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1. Report of the Auditor General for the year ended 31st March, 1914, Volume I, Parts A, B and A to L; Volume II, Parts M to U; Volume III, Parts V to Z. Presented by Hon. Mr. White, February 9, 1915.. .. .. ..*Printed for distribution and sessional papers.*

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2. The Public Accounts of Canada, for the fiscal year ended 31st March, 1914. Presented by Hon. Mr. White, February 9, 1915 .. .. ..*Printed for distribution and sessional papers.*

3. Estimates of sums required for the service of the Dominion for the year ending on 31st March, 1916. Presented by Hon. Mr. White, February 8, 1915.
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4. Supplementary Estimates of sums required for the service of the Dominion for the year ending on the 31st March, 1915. Presented by Hon. Mr. White, March 9, 1915.
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5. Further Supplementary Estimates of sums required for the service of the Dominion for the year ending on the 31st March, 1915. Presented by Hon. Mr. White, March 27, 1915.
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5*a*. Further Supplementary Estimates for year ending 31st March, 1916. Presented by Hon. Mr. White, March 31, 1915.. .. ..*Printed for distribution and sessional papers.*

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6. List of Shareholders in the Chartered Banks of the Dominion of Canada as on 31st December, 1914. Presented by Hon. Mr. White, February 9, 1915.
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7. Report on certified cheques, dividends, unclaimed balances and drafts or bills of exchange remaining unpaid in Chartered Banks of the Dominion of Canada, forfi ve years and upwards prior to 31st December, 1913. Presented by Hon. Mr. White, April 10, 1915.
Printed for distribution and sessional papers.

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(This volume is bound in two parts).

8. Report of Superintendent of Insurance for year 1914. Presented by Hon. Mr. White, 1915.
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9. Abstract of Statement of Insurance Companies in Canada for year ended 31st December, 1914. Presented by Hon. Mr. White, 1914.
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10. Report of the Department of Trade and Commerce for the fiscal year ended 31st March, 1914: Part I.—Canadian Trade. Presented by Sir George Foster, 8th February, 1915.
Printed for distribution and sessional papers.

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10*a*. Report of the Department of Trade and Commerce for the fiscal year ended 31st March, 1914: Part II.—Canadian Trade with (1) France, (2) Germany, (3) United Kingdom, and (4) United States. Presented by Sir George Foster, 8th February, 1915.
Printed for distribution and sessional papers.

10*b*. Report of the Department of Trade and Commerce for the fiscal year ended 31st March, 1914: Part III.—Canadian Trade with foreign countries (except France, Germany, the United Kingdom, and United States.) Presented by Sir George Foster, 8th February, 1915.. .. ..*Printed for distribution and sessional papers.*

10*c*. Report of the Department of Trade and Commerce, for the fiscal year ended 31st March, 1914, (Part IV, Miscellaneous Information.) Presented by Sir George Foster, March 27, 1915.. .. ..*Printed for distribution and sessional papers.*

10*d*. Report of the Board of Grain Commissioners for Canada. Presented by Sir George Foster, 1914... .. ..*Printed for distribution and sessional papers.*

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10*e*. Report of the Department of Trade and Commerce for the fiscal year ending 31st March, 1914. Part VI.—Subsidized Steamship Services, with statistics showing steamship traffic to 31st December, 1914, and Estimates for the fiscal year 1915-16. Presented by Sir George Foster, 1915.. .. ..*Printed for distribution and sessional papers.*

10*f*. Report of Trade and Commerce for fiscal year ended 31st March, 1914. (Part VII.—Trade of Foreign Countries, Treaties and Conventions.) Presented by Sir George Foster, 1915... .. ..*Printed for distribution and sessional papers.*

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11. Report of the Department of Customs for the year ended 31st March, 1914. Presented by Hon. Mr. Reid, February 11, 1915.. .. *Printed for distribution and sessional papers.*

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15. Report of the Minister of Agriculture for the Dominion of Canada, for the year ended 31st March, 1914. Presented by Hon. Mr. Burrell, February 8, 1915.
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15*a*. Report of the Dairy and Cold Storage Commissioner for the fiscal year ended 31st March, 1914 (Dairying, Fruit, Extension of Markets and Cold Storage). Presented by Hon. Mr. Burrell, 1915.. .. ..*Printed for distribution and sessional papers.*

15*b*. Report of the Veterinary Director General for the year ending 31st March, 1915. Presented by Hon. Mr. Burrell, 1915.. .. ..*Printed for distribution and sessional papers.*

16. Report of the Director and Officers of the Experimental Farms for the years ending 31st March, 1914 Presented by Hon. Mr. Burrell, March 1, 1915.
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17. Criminal Statistics for the year ended 30th September, 1913. (Appendix to the Report of the Minister of Trade and Commerce for the year 1913.) Presented by Sir George Foster, 1915 . .. .*Printed for distribution and sessional papers.*

18. Return of By-elections for the House of Commons of Canada, held during the year 1914. Presented by Hon Mr Speaker, March 12, 1915.
Printed for distribution and sessional papers.

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19. Report of the Minister of Public Works on the works under his control for the fiscal year ended 31st March, 1914, Volume I. Presented by Hon Mr Rogers, February 8, 1915
Printed for distribution and sessional papers.

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20. Annual Report of the Department of Railways and Canals, for the fiscal period from 1st April, 1913, to 31st March, 1914. Presented by Hon. Mr. Cochrane, March 12.
Printed for distribution and sessional papers.

20*a*. Canal Statistics for the season of navigation, 1914. Presented by Hon. Mr. Cochrane, 9th April, 1915.. .. ..*Printed for distribution and sessional papers.*

20*b*. Railway Statistics of the Dominion of Canada, for the year ended 30th June, 1914. Presented by Hon. Mr. Cochrane, March 12, 1915.
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20*c*. Ninth Report of the Board of Railway Commissioners for Canada, for the year ending 31st March, 1914. Presented by Hon. Mr. Cochrane, February 8, 1915.
Printed for distribution and sessional papers.

20*d*. Telephone Statistics of the Dominion of Canada, for the year ended 30th June, 1914. Presented by Hon. Mr. Cochrane, March 17, 1915.
Printed for distribution and sessional papers.

20*e*. Express Statistics of the Dominion of Canada for year ended 30th June, 1914. Presented by Hon. Mr. Cochrane, 1915... .. ..*Printed for distribution nad sessional papers.*

20*f*. Telegraph Statistics of the Dominion of Canada, for the year ended 30th June, 1914. Presented by Hon. Mr. Cochrane, March 17, 1915.
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21. Forty-seventh Annual Report of the Department of Marine and Fisheries, for the year 1913-1914—Marine. Presented by Hon. Mr. Hazen, February 8, 1915.
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21*b*. Report and evidence in connection with the Royal Commission appointed to investigate the disaster of the *Empress of Ireland*. Presented by Hon. Mr. Hazen, 1914.
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22. List of Shipping issued by the Department of Marine and Fisheries, being a list of vessels on the registry books of the Dominion of Canada on 31st December, 1914. Presented by Hon. Mr. Hazen, 1915... .. ..*Printed for distribution and sessional papers.*

23. Supplement to the Forty-seventh Annual Report of the Department of Marine and Fisheries for the fiscal year 1913-14—Steamboat Inspection Report. Presented by Hon. Mr. Hazen, March 3, 1915 .. ..*Printed for distribution and sessional papers.*

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25*b*. Annual Report of the Topographical Surveys Branch of the Department of the Interior, 1912-13. Presented by Hon. Mr. Roche, 1914.
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25*c*. Report of progress of stream measurements for calendar year of 1914. Presented by Hon. Mr. Roche, 1914.. .. ..*Printed for distribution and sessional papers.*

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25*e*. Report on Bow River Water Power and Storage Investigations, seasons 1911-1912-1913. Presented by Hon. Mr. Burrell, 1915.. ..*Printed for distribution and sessional papers.*

25*f*. Report of the British Columbia Hydrographic Survey for the calendar year 1913. Presented by Hon. Mr. Burrell, 1915.. ...*Printed for distribution and sessional papers.*

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26*a*. Summary Report of the Mines Branch for the calendar year 1913. Presented, 1914.
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27. Report of the Department of Indian Affairs for the year ended 31st March, 1914. Presented by Hon. Mr. Roche, 11th February, 1915.
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28. Report of the Royal Northwest Mounted Police, 1914. Presented by Hon. Sir Robert Borden, 8th February, 1915 .. ..*Printed for distribution and sessional papers.*

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29. Report of the Secretary of State of Canada for the year ended 31st March, 1914. Presented by Hon. Mr. Coderre, 9th February, 1915.
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29*b*. Report of the work of the Public Archives for the year 1913. Presented, 1915.
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30. The Civil Service List of Canada, 1914. Presented by Hon. Mr. Coderre, 9th February, 1915.. .. ..*Printed for distribution and sessional papers.*

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31. Sixth Annual Report of the Civil Service Commission of Canada for the year ended 31st August, 1914. Presented by Hon. Mr. Coderre, 19th March, 1915.
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32. Annual Report of the Department of Public Printing and Stationery for the year ended 31st March, 1914. Presented by Hon. Mr. Coderre, 6th April, 1915
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33. Report of the Secretary of State for External Affairs for the year ended 31st March, 1914. Presented by Sir Robert Borden, 18th February, 1915.
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34. Report of the Minister of Justice as to Penetentiaries of Canada, for the fiscal year ended 31st March, 1914. Presented, 1915.. .. ..*Printed for distribution and sessional papers.*

35. Report of the Militia Council for the Dominion of Canada, for the fiscal year ending 31st March, 1914. Presented by Hon. Mr. Hughes, 10th February, 1915.
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36. Report of the Department of Labour for the fiscal year ending 31st March, 1914. Presented by Hon. Mr. Crothers, 8th February, 1915.
Printed for distribution and sessional papers.

36a. Seventh Report of the Registrar of Boards of Conciliation and Investigation of the proceedings under "The Industrial Disputes Investigation Act, 1907," for the fiscal year ending 31st March, 1914. Presented by Hon. Mr. Crothers, 8th February, 1915.
Printed for distribution and sessional papers.

37. Tenth Annual Report of the Commissioners of the Transcontinental Railway, for the year ended 31st March, 1914. Presented by Hon. Mr. Cochrane, 8th February, 1915.
Printed for distribution and sessional papers.

37a. Interim Report of the Commissioners of the Transcontinental Railway, for the nine months ended 31st December, 1914. Presented by Hon. Mr. Cochrane, 15th February, 1915.. .. ..*Not printed.*

38. Report of the Department of the Naval Service, for the fiscal year ending 31st March, 1914 Presented by Hon. Mr. Hazen, 8th February, 1915.
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39. Forty-seventh Annual Report of the Department of Marine and Fisheries, 1913-14—Fisheries. Presented by Hon. Mr. Hazen, 8th February, 1915
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39a. Fisheries Investigations in Hudson's and James Bays. Presented by Hon. Mr. Hazen, 1915.. .. ..*Printed for distribution and sessional papers.*

39b. Supplement to the 47th Annual Report of the Department of Marine and Fisheries (Fisheries Branch),—Contributions to Canadian Biology, 1911-14, Part I—Marine Biology Presented by Hon. Mr. Hazen, 16th February, 1915.
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40. The Report of the Joint Librarians of Parliament. Presented by Hon. Mr. Speaker, 4th February, 1914 .. ..*Not printed.*

41. Report of R. A. Pringle, K.C., Commissioner appointed to investigate into the payment of subsidies to the Southampton Railway Company, together with the evidence, etc., taken before the Commissioner. Presented by Hon. Mr. Cochrane, 8th February, 1915.
Not printed.

42. Radiotelegraph Regulation 106 concerning the wave length for use by Canadian licensed ship stations during the period of hostilities, and

Amendment to the Radiotelegraph Regulations, Nos. 103 (Ship Stations in Territorial Waters) and 104 (Ship Stations in Harbours). Presented by Hon. Mr. Hazen, 8th February, 1915.. .. ..*Not printed.*

43. No. P. C. 260, dated 3rd February, 1915, *re* Establishment of Rank of Mate in the Royal Canadian Navy. Presented by Hon. Mr Hazen, 8th February, 1915... ..*Not printed.*

43a. Copy of Order in Council No. P.C. 304, dated 18th February, 1915.—Establishment of ranks of Lieutenant-Commander, Engineer Lieutenant-Commander and Lieutenant-Commander R.C.N.V.R., in the Royal Canadian Navy. Presented by Hon. Mr. Hazen, 11th March, 1915.. .. ..*Not printed.*

43b. Copy of Order in Council No. P.C. 476, dated 6th March, 1915,—Regulations concerning the classification of engineer officers. Presented by Hon. Mr. Hazen, 15th March, 1915.
Not printed.

44. Copies of Orders in Council *re* Naval Service.

No. P.C. 2175, dated 21st August, 1914, *re* Extra Rates of Pay for Service in Submarine Vessels.

No. P.C. 2251, *re* Rates of Pay and Allowances for Petty Officers and Men Volunteering for War Service.

No. P.C. 2960, *re* Scheme of Separation Allowance for the Dependents of those serving in H.M.C. ships. Presented by Hon. Mr. Hazen, 8th February, 1915
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45. Return to an Order of the House of the 20th April, 1914, for a copy of all letters, papers, tenders and other documents in regard to the purchase of any cars for the Intercolonial Railway during the years 1912 and 1913. Presented 9th February, 1915.—*Mr. Macdonald*.. .. ..*Not printed.*

45a. Return to an Order of the House of the 15th February, 1915, for a copy of all letters, telegrams, contracts, and other documents relating to the purchase of cars by the Intercolonial Railway since 1st July, 1914. Presented 9th April, 1915.—*Mr. Macdonald.* *Not printed.*

46. Return to an Order of the House of the 26th February, 1914, for a return showing:—1. The average cost per mile of construction of the Canadian Pacific Railway from its inception to date. 2. The average cost per mile in the last ten years. 3. The average rental per mile of lines leased by the Canadian Pacific Railway Company, and the names of such leased lines. 4. The rental paid by the Canadian Pacific Railway for the Toronto, Grey and Bruce Railway from Toronto to Owen Sound. Presented 9th February, 1915.—*Mr. Middlebro*.. .. ..*Not printed.*

47. Return to an Order of the House of the 1st June, 1914, for a return showing the revenue derived from freight received at and forwarded from the following stations on the Intercolonial Railway during the fiscal years 1913 and 1914, giving separately the amount for each of said stations, viz.: Drummondville, Rimouski, Ste. Flavie, Matapedia, Campbellton and Bathurst. Presented 9th February, 1915.—*Mr. Boulay.* *Not printed.*

48. Return to an Order of the House of the 1st June, 1914, for a return showing the names of the staff employed in the several departments of the general offices of the Intercolonial Railway at Moncton, together with their salaries respectively as of 1st April, 1914. Presented 9th February, 1915.—*Mr. Emmerson*.. .. ..*Not printed.*

49. Return to an Order of the House of the 18th May, 1914, for a return showing the names of the men who have been appointed to positions in the Prince Edward Railway Service from the 1st January, 1912, to the 1st May, 1914; the positions held by such appointees and the salary or wages attached to each position. Presented 9th February, 1915.—*Mr. Hughes (Kings, P.E.I.)*.. .. ..*Not printed.*

49a. Return to an Order of the House of the 1st March, 1915, for a return giving the names and post office addresses of all persons appointed to positions on the Prince Edward Island Railway from the 1st of October, 1911, to the present time; with a description of the position to which each person was so appointed. Presented 22nd March, 1915.—*Mr. Hughes (Kings, P.E.I.)*.. .. ..*Not printed.*

50. Return to an Order of the House of the 11th February, 1914, for a return showing the names, tonnage, port of registry and destination of all foreign vessels engaged in fishing, both sail and steam, that entered and cleared from the port of North Sydney during the year ending 31st December, 1913. Presented 9th February, 1915.—*Mr. Sinclair*.. .. ..*Not printed.*

51. Return to an Order of the House of the 1st June, 1914, for a copy of all correspondence between the Department of Justice and the Attorney General of Quebec, with regard to the appointment of judges, since the 1st of February, 1913. Presented 9th February, 1915.—*Sir Wilfrid Laurier*.. .. ..*Not printed.*

52. Return to an Order of the House of the 30th March, 1914, for a return showing:—1. Particulars of the inventories and value of the estate of the late George A. Montgomery, Registrar at Regina, whose estate escheated to the Crown. 2. The amount realized at Regina or elsewhere, on the conversion of said estate into money. 3. The costs paid or allowed with names and amounts paid or allowed before the residue was paid over to the Crown. 4. The amount paid over and actually received by the Crown. 5. The disposition of the fund and the names of the persons to whom any sum has been paid, and the respective amounts thereof so paid over or allowed since the Crown received the same. 6. A statement showing the difference between the reports of the present and the late Minister of Justice as to disposition of the fund, and a copy of such correspondence and representations as led up to any change. 7. The actual balance now on hand and the intended disposition thereof. Presented 9th February, 1915.—*Mr. Graham*.. .. ..*Not printed.*

53. Return to an Order of the House of the 16th March, 1914, for a return showing all persons, male or female, who have been capitally convicted in Canada, and each province, for each year, from the 1st of July, 1867, to the 2nd of February, 1914, specifying the offences and whether and how the sentences were carried into effect by execution, or otherwise, with the name of convicts; dates of conviction; crime of which committed; sentences passed; judges by whom sentenced; and how dealt with. 2. For a return showing all convicts, male and female, who have been reprieved from the execution of capital sentences passed upon them during the above mentioned period, with the name

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of convicts, dates of conviction; crime of which convicted; sentences passed, by whom sentenced; sentences commuted, and if so, to what. 3 For a return showing all persons in Canada, and each province, convicted during the above mentioned period of murder whose sentences have been mitigated, or who have received a free pardon, together with a statement of the offences of which they were severally convicted, with the name of convicts; dates of conviction; nature of offence; sentences; and extent of mitigation of sentences and dates. 4. For a return of instances, during the above mentioned period, in which appeal has been made on behalf of the persons convicted of capital offences to His Excellency, the Governor in Council, for the exercise of the Royal Prerogative of pardon, or mitigation of sentences, with the name of convicts; dates of conviction and place; crime of which convicted; sentences; dates of appeal; and the result. Presented 9th February, 1915.—*Mr. Wilson (Laval)*.. ..*Not printed*

54. General Rules and Orders of the Exchequer Court of Canada made, respectively, on the 23rd September, 1911, and the 18th June, 1914. Presented by Hon. Mr. Coderre, 9th February, 1915.. .. ..*Not printed*

54*a*. General Rules and Orders of the Exchequer Court of Canada made on the 15th February, 1915. Presented by Hon. Mr. Coderre, 16th March, 1915... .. ..*Not printed.*

55. Ordinances of the Yukon Territory passed by the Yukon Council in the year 1914 Presented by Hon. Mr. Coderre, 9th February, 1915... .. ..*Not printed.*

56. Return to an Order of the House of the 18th May, 1914, for a return showing the details of moneys paid to J. F. Farrington, $218.25; B. H. Smith, $169.50, and H. C. Dash, $182.40, as set forth in *Hansard* of this session, page 3071. Presented 9th February, 1915.—*Mr. McLean (Halifax)*... .. ..*Not printed.*

57. Return to an Order of the House of the 16th March, 1914, for a copy of instruction sent to Mr. Wm. Flynn, advocate, to hold investigations into charges made against employees of the Department of Marine and Fisheries in Bonaventure County, and reports made by him in such investigations. Presented 9th February, 1915.—*Mr. Marcil (Bonaventure)*.. .. ..*Not printed.*

58. Return to an Order of the House of the 27th April, 1914, for a copy of all documents bearing upon the application made to the Department of Marine and Fisheries for the dismissal of Ulric Dion, lightkeeper at St. Charles de Caplan, Quebec, and the appointment of Omer Arsenault in his place, and on the action taken by the Department in that connection. Presented 9th February, 1915.—*Mr. Marcil (Bonaventure).*
Not printed.

59. Return to an Order of the House of the 9th February, 1914, for a copy of all agreements made and entered into between the Department of Marine and Fisheries or the Government and Railway and Express Companies, including the Intercolonial Railway, relating to the transportation of fresh fish by fast freight or express, since the year 1906; also a copy of all guarantees given to railway and express companies by the Government or any Department thereof, relating to such transportation, together with a statement of all disbursements made by the Department of Marine and Fisheries each year under the terms of such agreements or guarantees, distinguishing between disbursements made on account of fast freight and disbursements made on account of express shipments; also the number of refrigerator cars, subject to guarantee, by Department of Marine and Fisheries, forwarded by fast freight from Mulgrave or Halifax to Montreal, each calendar year since 1906, and the number of tons of freight carried by such cars each year Also the number of refrigerator express cars forwarded from said points, Mulgrave and Halifax to Montreal, up to December 31, 1913, under the terms of an agreement made since 1911, between the Department of Marine and Fisheries and the railway or express companies or both. Also the number of tons of fresh fish carried by express companies, prior to December 31, 1913, under the last mentioned agreement; and the amount paid up to December 31, 1913, by the Department of Marine and Fisheries, under the last mentioned agreement. Also the number of tons of fresh fish carried by express companies from Mulgrave and Halifax to points west since 1906, on which the Government paid one-third, but not under the terms of the said agreement made as aforesaid, since 1911. Presented 9th February, 1915.—*Mr. Sinclair*.. .. ..*Not printed*

60. Return to an Order of the House of the 20th April, 1914, for a return showing all the post offices in the several counties in the province of Nova Scotia for which a rent allowance, or a fuel fund, and light allowance is made, specifying the amount of such allowance in each case. Presented 9th February, 1914—*Mr. Chisholm (Antigonish).*
Not printed

61. Return to an Order of the House of the 16th March, 1914, for a copy of all correspondence, letters, telegrams, etc., in the year 1913, relating to the carrying of the mails between Grand River Falls and Grand River, county of Richmond, and the awarding of the contract to Malcolm McCusple. Presented 9th February, 1915.—*Mr Kyte.*
....*Not printed.*

CONTENTS OF VOLUME 28—*Continued.*

62. Return to an Order of the House of the 11th May, 1914, for a copy of all letters, telegrams, correspondence and memorials since the 1st day of November, 1911, relating to the post office at Johnstown, Richmond County, N.S., and to complaints against the present postmaster and recommendations for his dismissal. Presented 9th February, 1915.—*Mr. Kyte*.. .. .. *Not printed.*

63. Return to an Order of the House of the 20th April, 1914, for a copy of all papers, petitions, letters and telegrams concerning the change of site of the post office at St. Lazare Village, county of Bellechasse, Quebec. Presented 9th February, 1915.—*Mr. Lemieux.* ....*Not printed.*

64. Statement of Governor General's Warrants issued since the last Session of Parliament on account of 1914-15. Presented by Hon. Mr. White, 9th February, 1915. *Not printed.*

65. Statement of expenditure on account of "Miscellaneous Unforeseen Expenses," from the 18th August, 1914, to the 4th February, 1915, in accordance with the Appropriation Act of 1914. Presented by Hon. Mr. White, 9th February, 1915.. .. .. ..*Not printed.*

66. Statement of Superannuation and Retiring Allowances in the Civil Service during the year ending 31st December, 1914, showing name, rank, salary, service, allowance and cause of retirement of each person superannuated or retired, also whether vacancy is filled by promotion or by appointment, and salary of any new appointee. Presented by Hon. Mr. White, 9th February, 1915.. .. ..*Not printed.*

67. Statement of receipts and expenditures of the Ottawa Improvement Commission to 31st March, 1914. Presented by Hon. Mr. White, 9th February, 1915.. .. ..*Not printed.*

68. Statement of the affairs of the Royal Society of Canada, for the year ended 30th April, 1914. Presented by Hon. Mr. White, 9th February, 1915.. .. ..*Not printed.*

69. Account of the average number of men employed on the Dominion Police Force during each month of the year 1914, and of their pay and travelling expenses, pursuant to Chapter 92, Section 6, Subsection 2, of the Revised Statutes of Canada. Presented by Hon. Mr. Doherty, 10th February, 1915.. .. ..*Not printed.*

70. Return to an Order of the Senate, dated the 16th January, 1913, calling for copy of the plans, reports, soundings, and other germane information respecting the ports of Churchill and Fort Nelson, so far as the Department of Railways and Canals is concerned.—*(Senate)*.. .. ..*Not printed.*

71. Return to an Order of the Senate, dated the 29th April, 1914, showing:—1. Titles of all books, pamphlets and other printed papers issued by the King's Printer during the year ending on the 31st of March, 1914. 2. The number of each of such books, pamphlets and papers printed during such year, and the number distributed, with the dates of distribution. 3. The number of pages in each. 4. The cost of each. 5. The authority for the printing and issuing of each of such books, pamphlets and papers.—*(Senate)*.. .. ..*Not printed.*

72. Return to an Order of the Senate dated the 30th April, 1914, for the production of all proposals submitted to the Government for the construction of the Montreal, Ottawa and Georgian Bay Canal and all the correspondence relating thereto.—*(Senate).* *Not printed.*

72*a*. Return to an Order of the House of the 11th February, 1915, for a copy of all petitions and memoranda from commercial bodies or other parties in relation to the immediate construction of the Georgian Bay Canal, and of all correspondence in connection with the same since 21st September, 1911. Presented 4th March, 1915.—*Sir Wilfrid Laurier.* *Not printed.*

73. Copies of general orders promulgated to the militia for the period between 25th November, 1913, and 24th December, 1914.—*(Senate)*... .. ..*Not printed.*

74. Copy of correspondence respecting the control of the exportation of nickel. Presented by Sir Robert Borden, 11th February, 1915.. .. ..*Not printed.*

75. Memorandum respecting work of the Department of Militia and Defence—European War, 1914-15. Presented by Hon. Mr. Hughes, 11th February, 1915.. .. .. ..*Not printed.*

76. Return to an Order of the House of the 6th April, 1914, for a copy of all correspondence, letters, telegrams, complaints and documents of all kinds received by the Department of Trade and Commerce during the years 1913-14, with respect to the Pictou-Mulgrave-Cheticamp steamship route. Presented 11th February, 1915.—*Mr. Chisholm (Inverness)* .. ..*Not printed.*

CONTENTS OF VOLUME 28—*Continued.*

77. Return to an Order of the House of the 8th June, 1914, for a copy of all documents bearing on an application or applications made to the Superintendent General of Indian Affairs or the Department, on an amendment to the Indian Act to facilitate the sale of the Indian Reserve of Restigouche, Que., or on the acquiring otherwise of any portion or the whole of the said reserve for industrial or other purposes, and any answers given thereto. Presented 11th February, 1915.—*Mr. Marcil (Bonaventure).* *Not printed.*

78. Return to an Order of the House of the 2nd February, 1914, for a return showing the names of the sailors who have been employed on the *Eureka* during the years 1910, 1911, 1912 and 1913. Presented 12th February, 1915.—*Mr. Boulay.. .. ..Not printed.*

79. Return to an Order of the House of the 15th April, 1914, for a return showing the total bond issue of the Canadian Northern Railway Company and its affiliated companies; and the total cost to date of the construction of the lines of railways comprising the Canadian Northern Railway system, including terminals, sidings, etc. Presented 12th February, 1915.—*Mr. Murphy.. .. ..Not printed.*

80. Return to an Order of the House of the 18th May, 1914, for a copy of all papers, documents, reports and evidence relative to the dismissal or proposed dismissal of W. A. Case of the Government Quarantine Service at Halifax, N.S. Presented 12th February, 1915.—*Mr. McLean (Halifax) .. ..Not printed.*

81. Return to an Order of the House of the 26th February, 1914, for a return showing:—1. The freight rates charged during the years 1912 and 1913, on wheat from Canadian ports to ports in the United Kingdom by the Canadian Pacific Railway Company's Steamship Lines, the Allan Steamship Line and the Canadian Northern Railway Company's Steamship Lines. 2. The profits made by the freight boats of the said several lines which carried wheat alone or with other freight. Presented 12th February, 1915.—*Sir James Aikins.. .. ..Not printed.*

82. Return to an Order of the House of the 16th February, 1914, for a copy of all reports, requests, petitions, memorials, letters, telegrams and other correspondence and documents relating to the removal, suspension or dismissal, by the management of the Intercolonial Railway, of Warren Carter and Frederick Avard, employees in the freight department of the Intercolonial Railway at Sackville, N.B.; and of all letters, telegrams and other correspondence in the Department of Railways and Canals, or in the railway offices at Moncton, or in any Department of Government, addressed to the Minister of Railways and Canals, or to any other member of the Government, or to any official of the Department of Railways and Canals, or of the Intercolonial Railway, by any person or persons in the county of Westmorland, N.B., in any manner relating to said employees and to the dispensing with their services, particularly of any letters sent to F. P. Brady, General Superintendent of the Intercolonial, by any party or parties in Sackville, N.B., or elsewhere, and of all replies to any such letters, correspondence or documents. Presented 12th February, 1915.—*Mr. Emmerson.* *Not printed.*

83. Return to an Order of the House of the 23rd March, 1914, for a return showing:—1. What investigations and other work have been entrusted by the Government, or any Department thereof, to G. Howard Ferguson, member for the electoral division of the county of Grenville in the Legislative Assembly of the province of Ontario. 2. How much the said G. Howard Ferguson has been paid by the Government, or any Department thereof, for fees and disbursements since the 21st of September, 1911, and how much is still due and owing to him. 3. How much has been paid to the said G. Howard Ferguson by the Government or any Department thereof, since the 21st September, 1911, in connection with any other matter whatever. Presented 12th February, 1915.—*Mr. Proulx.. .. ..Not printed.*

84. Further Supplementary Return to an Order of the House of the 28th April, 1913, for a return showing a list of all the newspapers in Canada in which advertisements have been inserted by the Government, or any minister, officer or department thereof, between 10th October, 1911, and the present date, together with a statement of the gross amount paid therefor between the above dates to each of said newspapers or to the proprietors of the same. Presented 12th February, 1915.—*Mr. Sinclair.. .. ..Not printed.*

84*a*. Further Supplementary Return to an Order of the House of the 30th April, 1913, for a return showing a list of all the newspapers in Canada in which advertisements have been inserted by the Government, or any minister, officer or department thereof, between the 10th day of October, 1906, and 10th October, 1907, and between said dates in each of the years following up to the 10th October, 1911, together with a statement of the gross amount paid therefor for the years mentioned, to each of the said newspapers or the proprietors of the same. Presented 12th February, 1915.—*Mr. Thornton.* *Not printed.*

CONTENTS OF VOLUME 28—*Continued.*

85. Partial Return to an Order of the House of the 4th March, 1914, for a return showing:—1. How many employees of the Federal Government of Canada, including all services and all departments, have been dismissed from 10th October, 1911, to the present date. 2. How many have resigned. 3. How many have deserted the service. 4. How many deserters have been punished. 5. How many new employees have been engaged or appointed by the present Government during the same period. Presented 12th February, 1915.—*Mr. Boivin*. . . . .*Not printed.*

85a. Return to an Order of the House of the 4th March, 1914, for a return showing:—1. How many employees of the Federal Government of Canada, including all services and all departments, have been dismissed from 10th October, 1911, to the present date. 2. How many have resigned. 3. How many have deserted the service. 4. How many deserters have been punished. 5. How many new employees have been engaged or appointed by the present Government during the same period. Presented 4th March, 1915.—*Mr. Boivin*. . . . .*Not printed.*

85b. Further Supplementary Return to an Order of the House of the 4th March, 1914, for a return showing:—1. How many employees of the Federal Government of Canada, including all services and all departments, have been dismissed from 10th October, 1911, to the present date. 2. How many have resigned. 3. How many have deserted the service. 4. How many deserters have been punished. 5. How many new employees have been engaged or appointed by the present Government during the same period. Presented 5th March, 1915.—*Mr. Boivin*. . . . .*Not printed.*

85c. Further Supplementary Return to an Order of the House of the 4th March, 1914, for a return showing:—1. How many employees of the Federal Government of Canada, including all services and all departments, have been dismissed from 10th October, 1911, to the present date. 2. How many have resigned. 3. How many have deserted the service. 4. How many deserters have been punished. 5. How many new employees have been engaged or appointed by the present Government during the same period. Presented 12th March, 1915.—*Mr. Boivin*. . . . .*Not printed.*

85d. Further Supplementary Return to an Order of the House of the 4th March, 1914, for a return showing:—1. How many employees of the Federal Government of Canada, including all services and all departments, have been dismissed from 10th October, 1911, to the present date. 2. How many have resigned. 3. How many have deserted the service. 4. How many deserters have been punished. 5. How many new employees have been engaged or appointed by the present Government during the same period. Presented 7th April, 1915.—*Mr. Boivin*. . . . .*Not printed.*

86. Further Supplementary Return to an Order of the House of the 18th February, 1914, for a copy of all charges, complaints, memorials, correspondence and telegrams, not already produced, relating to officials in any department of the Government since 10th October, 1911, the number of officials dismissed, reports of investigations held in respect of such charges, items of expenditure and costs of each investigation, the names of persons appointed to office in the place of dismissed officials, and of all recommendations received in behalf of persons so appointed in the province of Prince Edward Island. Presented 12th February, 1915.—*Mr. Hughes (Kings, P.E.I.)*
Not printed.

87. Partial Return to an Order of the House of the 18th May, 1914, for a return showing in all cases in which Charles Seager, of Goderich, acted as Government Commissioner in the investigation of officials charged with partizanship, or other offences, from and including the year 1896 to the year 1900; and the names of all officials dismissed by reason of the reports of the said Charles Seager, the positions held by such officials, and when such dismissals took place; with a copy of the evidence taken in all such cases, together with the commissioners reports thereon, and also showing what fees were paid to the said Charles Seager for conducting such investigations. Presented 12th February, 1915.—*Mr. Clark (Bruce)*. . . . .*Not printed.*

88. Return to an Order of the House of the 16th March, 1914, for a copy of all correspondence, letters, telegrams, complaints and of all other documents in any way referring to the operation of the salmon hatchery at North East Margaree, and the fish pond at Margaree Harbour from 1911 to date. Presented 15th February, 1915.—*Mr. Chisholm (Inverness)*. . . . .*Not printed.*

89. Return to an Address to His Royal Highness the Governor General of the 11th May, 1914, for a copy of all letters, telegrams, Orders in Council, contracts, tenders, papers and other documents in possession of the Department of Public Works, and of the Department of Militia and Defence, relating to the construction of an armoury at Amherst, N.S. Presented 15th February, 1915.—*Mr. Sinclair*. . . . .*Not printed.*

90. Letters of the Honourable Louis P. Pelletier, M.P., and the Honourable Wilfrid B. Nantel, M.P., resigning their positions as Postmaster General and Minister of Inland Revenue, respectively, and letters of the Prime Minister in acknowledgment thereof. Presented by Sir Robert Borden, 15th February, 1915. . . . .*Not printd.*

CONTENTS OF VOLUME 28—*Continued.*

91. Report of Board of Officers on boots supplied to the Canadian Expeditionary Force. Presented by Hon. Mr. Hughes, 15th February, 1915.. .. ..*Not printed.*

92. Regulations under "The Destructive Insect and Pest Act." Presented by Hon. Mr Burrell, 16th February, 1915... .. ..*Not printed*

93. Report on "The Agricultural Instruction Act," 1913-14, pursuant to Section 8 of the above named Act. Presented by Hon. Mr. Burrell, 16th February, 1915.
Printed for sessional papers only

93*a*. Supplementary Return to an Address to His Royal Highness the Governor General of the 9th February, 1914, for a copy of all arrangements made between the Government and the various provinces under the Agricultural Instruction Act. Presented 19th February, 1915.—*Sir Wilfrid Laurier*.. .. ..*Not printed.*

93*b*. Return to an Order of the House of the 20th April, 1914, for a copy of all documents, correspondence, letters, petitions, reports, etc., exchanged between Dr. C. C. James, Mr. J. C. Chapais and each of the Provincial Ministers of Agriculture, in connection with the distribution and the administration of the federal subsidy granted to the provinces for agricultural purposes since the granting of same. Presented 23rd February, 1915. —*Mr. Lapointe (Kamouraska)*.. .. ..*Not printed.*

94. Return to an Order of the House of the 11th February, 1914, for a copy of all telegrams, correspondence, instructions, recommendations, and other documents that passed between the Shellfish Fishery Commission of 1913, and the Department of Marine and Fisheries, from the date of the appointment of said Commission to 31st December, 1913, excluding such documents as have been printed in the published report of said Commission. Presented 16th February, 1915.—*Mr. Sinclair*.. .. ..*Not printed.*

95. Return to an Order of the House of the 16th March, 1914, for a copy of all correspondence, tenders, telegrams, complaints and of all other documents in any way referring to the collecting of spawn for the Margaree Lobster Hatchery during the years 1911-12, 1912-13 and 1913-14. Presented 16th February, 1915.—*Mr. Chisholm (Inverness).*
Not printed.

96. Return to an Order of the House of the 10th February, 1915, for a return showing the amount of coal imported into Alberta, Saskatchewan and Manitoba, respectively, from the United States during the year 1914; also the amount of duty collected in each of the said provinces during the same year. Presented 16th February, 1915.—*Mr. Buchanan*... .. ..*Not printed.*

97. Copy of the Eighth Joint Report of the Commissioners for the Demarcation of the Meridian of the 141st Degree of West Lngitude. Presented by Hon. Mr. Roche, 18th February, 1915.. .. ..*Not printed.*

98. Return to an Order of the House of the 20th April, 1914, for a copy of the agreement between the Government of Canada and the Canadian Pacific Railway Company at the time the special land grant was made whereby the Canadian Pacific Railway Company were enabled to get their land grant in one block for the purpose of establishing their present irrigation system east of Calgary, province of Alberta. Presented 18th February, 1915.—*Mr. Burnham*.. .. ..*Not printed.*

99. Return to an Order of the House of the 23rd March, 1914, for a copy of all letters, telegrams and other documents in connection with the sale of any timber on Parry Island, Parry Sound District, and of advertisements, agreements for purchase and any other documents connected with such sale or grant of timber to any person or persons. Presented 18th February, 1915.—*Mr. Arthurs*.. .. ..*Not rpinted*

100. Return to an Order of the House of the 11th February, 1914, for a return showing reasons for the dismissal of Mr. Larivière, Dominion Lands Agent at Girouard; the date of his appointment and of dismissal and salary at time of dismissal; also the name of agent appointed in his place, with date of appointment and salary. Presented 18th February, 1915.—*Mr. Oliver*.. .. ..*Not printed*

101. Annual Return respecting Trade Unions under Chapter 125, R.S.C., 1906 Presented by Hon. Mr. Coderre, 18th February, 1915.. .. ..*Not printed.*

102. A detailed statement of all bonds or securities registered in the Department of the Secretary of State of Canada, since last return (21st January, 1914) submitted to the Parliament of Canada under Section 32 of Chapter 19, of the Revised Statutes of Canada, 1906. Presented by Hon. Mr. Coderre, 18th February, 1915.. .. ..*Not printed.*

CONTENTS OF VOLUME 28—*Continued.*

103. Return to an Order of the House of the 9th February, 1914, for a copy of all petitions, memorials, letters, telegrams, papers, and documents received by any department of the Government of Canada, or any Minister of the Crown from any company, corporation, person or persons, requesting the removal of any customs duties upon wheat or wheat products entering Canada, or protesting against any diminution or removal of such custom's duties, and any replies thereto. Presented 18th February, 1915.—*Mr. Maclean (Halifax)*.. .. ..*Not printed.*

104. Return to an Order of the House of the 20th April, 1914, for a copy of all correspondence, letters, documents or other papers relating to the cancellation of the entry of R. Bannatyne for the northwest ¼ of section 24, township 35, range 18, west of the 2nd meridian. Presented 19th February, 1915.—*Mr. Neely*.. .. ..*Not printed.*

105. Return to an Order of the House of the 16th February, 1914, for a return showing the name of the postmaster of the Parish of St. Romuald, county of Lévis, who, it is said, was dismissed from office since September, 1911, the reasons for such dismissal, the nature of the complaints made against him, the names of the parties who made those complaints, together with a copy of all correspondence and telegrams relating thereto, the name of the inquiring commissioner, and report of investigation, if any, and of all evidence taken at the investigation, the names of those who recommended the successor, names of the parties by whom the Government was represented at such investigation, with a detailed statement of all the accounts paid or to be paid by any department in connection with the aforesaid dismissal and investigation, the names of the parties who received any money or filed their accounts in connection with said investigation, and the amount awarded to or claimed by each of them. Presented 19th February, 1915.—*Mr Bourassa*.. .. ..*Not printed.*

106. Return showing lands sold by the Canadian Pacific Railway Company during the year which ended on the 30th September, 1914. Presented by Hon. Mr. Roche, 19th February, 1915.. .. ..*Not printed.*

107. Return to an Order of the House of the 10th June, 1914, for a return showing:—1. The amount of money sent through the post offices in the past five years outside Canada from the following Cape Breton post offices: Glace Bay, Caledonia Mines, Dominion No. 4, New Aberdeen, Bridgeford, Old Bridgeford, Reserve Mines, Sydney, Whitney Pier, Ashby, North Sydney, Sydney Mines, Florence, Dominion No. 6, and Port Marrien. 2. What countries was such money transmitted to. Presented 22nd February, 1915.—*Mr. Carroll*.. .. ..*Not printed.*

108. Return to an Order of the House of the 15th February, 1915, for a copy of all correspondence, telegrams and other documents in connection with the removal from the customs service at Lethbridge, Alberta, of Brown Pipes and A. R. Gibbons. Presented 23rd February, 1915.—*Mr. Buchanan*.. .. ..*Not printed.*

109. Return to an Order of the House of the 15th February, 1915, for a return giving the names of all the transports hired since 1st August, 1914, for the conveyance of troops, horses, stores and material to England, the name of each vessel owner, broker or other person through whom the vessel was chartered, the tonnage of each vessel, speed, rate paid per ton per week or month, minimum time for which engaged, date of agreement, date at which pay commenced, date at which pay ceased, and the total sum paid by the Government for hire and other charges. Presented 23rd February, 1915.—*Mr. Murphy*.. .. ..*Not printed.*

110. Return to an Order of the House of the 15th February, 1915, for a return showing:—1. How many transport wagons were purchased for the Second and Third Contingents? 2. From whom they were purchased, and the name of each person or firm? 3. How many were purchased from each? 4. What was the price paid per wagon? 5. If any tenders were asked? 6. If any tenders were received that were not accepted? 7. If so, what was the price tendered at? Presented 23rd February, 1915.—*Mr. Nesbitt.* *Not printed.*

111. Return to an Order of the House of the 11th February, 1915, for a return showing:—1. How many persons have been made prisoners of war since the declaration of war between the Allies, Germany and Austria? 2. Where they have been kept captive? 3. What is the name of each place of detention, and the name of the officer in charge of such place of detention? Presented 23rd February, 1915.—*Mr. Wilson (Laval).* *Not printed*

111*a* Return to an Order of the House of the 19th February, 1915, for a statement in detail of: The number of prisoners of war in this country; the number under parole; the number held in detention camps; the number of detention camps, where situated, how accessible, and the number of prisoners in each. The amount of cost to Canada in each of these camps, respectively, for subsistence, pay, clothing, transportation and supervision; the nature of work done by prisoners, and the total value of same to date. Presented 1st April, 1915.—*Mr. Clark (Red Deer)*.. .. ..*Not printed.*

CONTENTS OF VOLUME 28—*Continued.*

112. Return to an Order of the House of the 15th February, 1915, for a copy of all letters, telegrams, minutes of investigation and other documents relating to the dismissal of James Brennan, fireman Intercolonial Railway at Stellarton. Presented 25th February, 1915.—*Mr. Macdonald* . . . . *Not printed.*

113. Return to an Order of the House of the 11th February, 1915, for return showing if any official statement was given on behalf of the management of the Intercolonial Railway to the effect that wages would be paid in their absence to the employees of the railway who volunteered for active service. If so, when and by whom? If any order has been made by the Railway Department providing for such payment, and if so, when the said order was made. Presented 23rd February, 1915.—*Mr. Macdonald* . . . . *Not printed*

114. Return to an order of the House of the 9th February, 1915, for a copy of all papers, petitions, letters and telegrams exchanged between the Quebec Board of Trade and the Department of Railways and Canals concerning the circulation of trains on that section of the National Transcontinental Railway between Cochrane and Quebec City. Presented 23rd February, 1915.—*Mr. Lemieux* . . . . *Not printed.*

115. Return (in so far as the Department of the Interior is concerned) of copies of all Orders in Council, plans, papers and correspondence relating to the Canadian Pacific Railway, which are required to be presented to the House of Commons, under a resolution passed on 20th February, 1882, since the date of the last return, under such resolution. Presented by Hon. Mr. Roche, 24th February, 1915 . . . . *Not printed.*

116. Return showing:—1. Who the Remount Commissioners are for Western and Eastern Canada respectively? 2. When and by whom they were appointed, and what their general instructions were? 3. Why were the mobilization orders 1913, which provide for the purchase of remounts, ignored and civilians put in charge of the purchase of remounts? 4. The names of the purchasers and inspecting veterinary officers appointed by the Remount Commissioner for Eastern Canada, in the various remount divisions? 5. If any of the purchasers and inspecting veterinary officers have been stopped buying. If so, what their names are, and the reasons given by the Remount Commissioner for his action? 6. How many horses have been purchased between 1st December and 31st January, in each remount division in Eastern Canada, and the average price paid per horse? 7. What the average cost per horse is in each remount division to cover the expenses, including pay or allowances and all travelling and other expenses, between the said dates. Presented 24th February, 1915.—*Mr. Lemieux* . . *Not printed.*

117. Return showing:—1. From how many firms the Government have ordered ankle boots for the various contingents now being equipped for service? 2. The names of these firms? 3. How many ankle boots have been ordered from each firm? 4. How many ankle boots each firm have delivered up to date? 5. How many ankle boots each firm have yet to deliver? 6. The price that each firm is receiving for these ankle boots. Presented 24th February, 1915.—*Mr. Lemieux* . . . . *Not printed.*

118. Return to an Order of the House of the 22nd February, 1915, for a copy of all correspondence, recommendations, tenders and other papers on file in the office of the Department of Railways and Canals relating to supplying ice for the Intercolonial Railway at Mulgrave for the year 1915. Presented 25th February, 1915.—*Mr. Sinclair.*
Not printed.

119. Return to an Order of the House of the 18th February, 1915, for a return showing:—1. How many motor trucks were sent with the first contingent to England? 2. From whom they were purchased, and by whom they were manufactured? 3. What their capacity was? 4. What price was paid for them? 5. If any expert was employed by the Government in connection with their purchase. If so, who? 6. If any commission was paid by the Government to any one in connection with their purchase? 7. If the trucks have given satisfaction in service. If not, what defects were exhibited? 8. If a committee was appointed by the Militia Department or the Government in regard to the purchase of motor trucks for the second and further contingents. If so, who comprised it, and what were their special qualifications? 9. If one, Mr. McQuarrie, was a member of this committee. If so, is it true he was, and is still, an employee of the Russell Motor Car Company of Toronto? 10. If one, Owens Thomas, was employed as expert on the said Committee? If so, what he was paid, or what he is to be paid for his services, and how long his services were utilized? 11. If Mr. Thomas received any commission in connection with the purchases of motor trucks either from the Government or the manufacturers? 12. What recommendations were made by the said committee to the Militia Department or the Government in connection with purchases of motor trucks? 13. If the trucks have been purchased. If so, how many, from whom, and at what price? 14. If it is true that these trucks were purchased from the Kelly Company, Springfield, Ohio. If so, could not efficient and suitable trucks have been procured from Canadian manufacturers? 15. If it is true that the Government has decided to go into the motor truck business by placing orders with Canadian manufacturers for parts, and supplying such parts to assemblers in Canada. If so, is it true that orders have been, or are being placed with the Russell Motor Car Company, to manufacture engines? 16. Who recommended Mr Thomas to the Minister of the Militia or the Government? Presented 25th February, 1915.—*Mr. Copp*
Not printed.

CONTENTS OF VOLUME 28—*Continued.*

120. Return to an Order of the House of the 15th February, 1915, for a return showing whether any exportations of food-stuffs have been made since 1st August last, to European countries, other than the United Kingdom, France and Belgium, and if so, their nature and what countries. Presented 25th February, 1915.—*Mr. Cockshutt.* *Not printed.*

121. Return to an Order of the House of the 11th February, 1915, for a copy of the petition, papers, documents and letters in connection with the incorporation of the Dominion Trust Company, incorporated by Special Act of the Parliament of Canada in 1912, being Chapter 89 of 2 George V. Presented 25th February, 1915.—*Mr. Proulx.* *Not printed.*

121*a*. Return to an Order of the House of the 11th February, 1915, for a copy of all the correspondence exchanged between the Department of Justice and the Government of the province of British Columbia, or any of its members, with regard to a certain Act passed by the Legislature of the said province in 1913, being Chapter 89 of 2 George V., entitled: "An Act respecting the Dominion Trust Company." Presented 4th March, 1915.—*Mr. Proulx*.. .. ..*Not printed.*

122. Return to an Order of the House of the 11th February, 1915, for a copy of all correspondence which has passed between the Auditor General and the Militia Department or any other department of the Government service in regard to the expenditure under the War Appropriation Act. Presented 25th February, 1915.—*Mr. Maclean (Halifax).* *Printed for distribution and sessional papers.*

122*a*. Memorandum of the Accountant and Paymaster-General and the Director of Contracts of the Department of Militia and Defence, in respect to correspondence between the Auditor General and Militia Department, relating to expenditure under the War Appropriation Act. Presented by Hon. Mr. Hughes, 11th March, 1915.. .. ..*Not printed.*

123. Copy of all correspondence between the Minister of Finance and the Auditor General from 18th August to date, respecting purchases for overseas contingents, army contracts, or other purchases for military purposes, or under the operation of the Naval Service Act of 1910, or under Orders in Council relating to military matters. Presented by Hon. Mr. White, 25th February, 1915.. .. ..*Not rpinted.*

124. Certified copy of a report of the Committee of the Privy Council approved by His Royal Highness the Governor General on the 23rd January, 1915, on the subject of separation allowance to dependents of soldiers of the First Overseas Contingent. Presented by Hon. Mr. Rogers, 26th February, 1915.. .. ..*Not printed*

124*a*. Certified copy of a report of the Committee of the Privy Council approved by His Royal Highness the Governor General on the 28th January, 1915, in respect to applications from men who have enlisted in the corps raised for overseas service, to be allowed to marry and to have their wives placed on the separation allowance list. Presented by Hon. Mr. Rogers, 26th February, 1915.. .. ..*Not printed.*

125. Return to an Order of the House of the 16th February, 1914, for a copy of all telegrams, correspondence, petitions and documents of all kinds in any way referring to a drill shed or armoury to be built at the town of Inverness, Inverness county, Nova Scotia. Presented 26th February, 1915.—*Mr. Chisholm (Inverness)*.. .. ..*Not printed.*

126. Detailed statement of revenue of custom duties and refund thereof under Section 92 Consolidated Revenue and Audit Act, through the Department of Commerce for the fiscal year ended 31st March, 1914.—*(Senate)*.. .. ..*Not printed.*

127. Orders in Council which have been published in the *Canada Gazette* betewen the 1st December, 1913, and 11th January, 1915, in accordance with the provisions of Section 19, Chapter 10, 1-2 George V. "The Forest Reserves and Park Act."—*(Senate).* *Not printed.*

127*a*. Return of Orders in Council which have been published in the *Canada Gazette*, between the 16th May, 1914, and 25th July, 1914, in accordance with the provisions of "The Forest Reserves and Park Act," Section 19, of Chapter 10, 1-2 George V. Presented by Hon. Mr. Roche, 12th March, 1915.. .. ..*Not printed.*

128. Orders in Council which have been published in the *Canada Gazette* between 1st December, 1913, and 15th January, 1915, in accordance with the provisions of Section 5, of Chapter 21, 7-8 Edward VII, "The Dominion Lands Survey Act."—*(Senate).* *Not printed.*

128*a*. Return of Orders in Council which have been published in the *Canada Gazette*, between 24th January, 1914, and 6th February, 1915, in accordance with the provisions of Section 77 of "The Dominion Lands Act," Chapter 20 of the Statutes of Canada, 1908. Presented by Hon. Mr. Roche, 12th March, 1915.. .. ..*Not printed.*

CONTENTS OF VOLUME 28—*Continued.*

128*b*. Return of Orders in Council which have been published in the *Canada Gazette* and in the British Columbia *Gazette*, between 11th April, 1914, and 10th December, 1914, in accordance with provisions of Subsection (*d*) of Section 38 of the regulations for the survey, administration, disposal and management of Dominion Lands within the 40-mile railway belt in the province of British Columbia. . Presented by Hon. Mr. Roche, 12th March, 1915.. . . . . *Not printed.*

128*c*. Orders in Council which have been published in the *Canada Gazette* and in the *British Columbia Gazette*, between 1st December, 1913, and the 15th January, 1915, in accordance with the provisions of Subsection (*d*) of Section 38 of the Regulations for the survey, administration, disposal and management of Dominion Lands within the 40-mile railway belt in the province of British Columbia.—(*Senate*) . . . . . . *Not printed.*

129. Orders in Council passed between 1st December, 1913 and 15th January, 1915, approving of regulations and forms prescribed in accordance with the provisions of Section 57 of the Irrigation Act, Chapter 61, Revised Statutes of Canada, 1906, as amended by Chapter 38, 7-8 Edward VII.—(*Senate*) . . . . *Not printed.*

130. Return to an Order of the House of the 25th February, 1915, for a return showing whether the Government purchased from the Canada Cycle and Motor Company tires for motor trucks for the first Canadian Contingent and, if so, the price paid per set and the number purchased; also whether the Government have obtained prices for tires for motor trucks for the second contingent and, if so, the prices per set so obtained. Presented 3rd March, 1915.—*Mr. Gauvreau*. . . . . *Not printed.*

131. Return to an Order of the House of the 15th February, 1915, for a copy of all correspondence, telegrams and other documents in connection with the appointment of A. H. McKeown to the Immigration service at Lethbridge, Alberta. Presented 3rd March, 1915.—*Mr. Buchanan*. . . . . *Not printed.*

132. Return to an Order of the House of the 15th February, 1915, for a copy of all correspondence, telegrams and other documents in connection with the removal from office of A. E. Humphries, Inspector of Immigration at Lethbridge, Alberta. Presented 3rd March, 1915.—*Mr. Buchanan*. . . . . *Not printed.*

133. Return to an Order of the House of the 3rd June, 1914, for a return showing:—1. Who secured the mail contract between Armagh Station and Mailloux, county of Bellechasse, Que.? 2. How many tenders were received? 3. The names of the tenderers, and the amount of each tender? Presented 3rd March, 1915.—*Mr. Lemieux*. . . . . . *Not printed.*

134. Return to an Order of the House of the 6th April, 1914, for a copy of all letters, telegrams, correspondence, complaints, and documents of all kinds in any way connected with the asking for tenders for the mail route between Low Point and Creignish Station during the years 1913-14. Presented 3rd March, 1915.—*Mr. Chisholm (Inverness).* *Not printed.*

135. Return to an Order of the House of the 6th April, 1914, for a copy of all letters, telegrams and other documents relative to the mail contract between New Ross and Vaughans post office, Waterville, province of Nova Scotia. Presented 3rd March, 1915. —*Mr. Macdonald*. . . . . *Not printed.*

136. Return to an Order of the House of the 18th May, 1914, for a copy of all correspondence, telegrams, letters and documents of all kinds in possession of the Post Office Department received since 1913, up to the present date in any way referring to the mail contract from Mabou to Wycocomagh. Presented 3rd March, 1915.—*Mr. Chisholm (Inverness)* . . . . *Not printed*

137. Return to an Order of the House of the 25th February, 1915, for a return showing:—1. The amount of money collected by sub-collectors of customs at Edmundston, N.B., at Clair, N.B., at St. Leonards, N.B., and at Green River, N.B., each and every year for the last five fiscal years. 2. The salaries paid in connection with each of said ports each year. Presented 3rd March, 1915.—*Mr. Michaud*. . . . . *Not printed.*

138. Return to an Order of the House of the 10th February, 1915, for a return showing how much money has been spent amongst the merchants of the city of Medicine Hat for Government relief, to whom the payments were made and the total amount in each case. Presented 4th March, 1915.—*Mr. Buchanan*. . . . . *Not printed.*

139. Return to an Order of the House of the 2nd February, 1914, for a copy of all letters, correspondence, papers and documents relating to the dismissal of the following persons from the below mentioned offices in Shelburne County, N.S.:—J. V. Smith, sub-collector of customs at Lower Woods Harbour; John H. Lyons, keeper of lightship, Barrington Passage; William L. Smith, lightkeeper, Baccaro; E. D. Smith, fishery overseer, Shag Harbour; J. A. Orechia, harbour master, Woods Harbour; J. C. Morrison, harbour master, Shelburne; and Albert Mahaney, postmaster at Churchover. Presented 4th March, 1915.—*Mr. Maclean (Halifax)*. . . . . *Not printed.*

CONTENTS OF VOLUME 28—*Continued.*

139a. Return to an Order of the House of the 24th February, 1915, for a copy of all letters, papers and documents relating to the dismissal of the following officers in Shelburne County, N.S.: Wm. L. Smith, lightkeeper, Baccaro, N.S.; J. A. Arechia, harbour master, Lower Wood Harbour, and J. C. Morrison, harbour master, Shelburne, N.S. Presented 16th March, 1915.—*Mr. Law.* . . . .*Not printed.*

140. Return to an Order of the House of the 9th March, 1914, for a return showing:—1. The amounts of money expended by this Government in the county of Portneuf from the 1st of July, 1896, to the 21st September, 1911. 2. The nature of the work done in each parish. 3. In what year such work was executed, and what amount was expended in each case. Presented 4th March, 1915.—*Mr. Sevigny.* . . . .*Not printed.*

141. Return to an Order of the House of the 22nd February, 1915, for a copy of all papers, petitions, declarations, affidavits, sworn statements, requests, certificates and all other documents in connection with the naturalization of F. P. Gutelius, General Manager of the Intercolonial Railway. Presented 4th March, 1915.—*Mr. Gauvreau.* . . .*Not printed.*

142. Report of the delegates appointed to represent the Government of Canada at the Eighth International Purity Congress, held under the auspices of the World's Purity League, at Kansas City, Mo., November 5th-9th, 1914. Presented by Sir Robert Borden, 4th March, 1915. *Not printed.*

143. Return to an Address to His Royal Highness the Governor General of the 22nd February, 1915, for a copy of all complaints to the Government of the killing of one American citizen and the shooting of another by militia men, in the waters of Lake Erie, and of all correspondence with regard to the same with the British Embassy and American authorities. Presented 5th March, 1915.—*Sir Wilfrid Laurier.* . . . . . .*Not printed.*

144. Return to an Order of the House of the 24th February, 1915, for a return showing the amounts in detail paid to Ward Fisher, of Shelburne, N.S., fishery inspector, for the years 1912 and 1913, for salary, office expenses, travelling expenses, and all other expenses. Presented 5th March, 1915.—*Mr. Law.* . . . .*Not printed.*

145. Return to an Order of the House of the 15th February, 1915, for a return showing the names and addresses of all persons in Yarmouth County to whom the bounty under the Fenian Raid Volunteer Bounty Act has been paid; the names and addresses of all persons from said county whose applications have been rejected, and a list giving names and addresses of all applicants from said county whose applications have not yet been disposed of. Presented 5th March, 1915.—*Mr. Law.* . . . .*Not printed.*

146. Return to an Order of the House of the 19th February, 1915, for a return showing the names and post office addresses of all persons in Guysborough County, N.S., to whom the bounty under the Fenian Raid Volunteer Bounty Act has been paid; the names and post office addresses of all persons whose applications have been rejected, and the reason for such rejections; also the names and post office addresses of all persons whose applications have been received but have not yet been paid, distinguishing between those who have been dealt with and allowed, and such applications as have been received but not yet considered, if any. Presented 5th March, 1915.—*Mr. Sinclair.* *Not printed.*

147. Return to an Order of the House, of the 12th February, 1915, for a return showing:—1. How many applications for seed grain have been received from residents of the three prairie provinces since June, 1914? 2. How many bushels of grain were included in the applications? 3. How many acres of land were to be seeded by the grain applied for? 4. How many bushels of wheat, oats and barley, respectively, the Government has on hand with which to meet the applications? 5. If arrangements have been made under which the several Provincial Governments will assist in meeting the needs of the settlers for seed grain? Presented 8th March, 1915.—*Mr. McCraney.* . . .*Not printed.*

148. Return to an Order of the House, of the 2nd February, 1914, for a return showing the number of ships chartered by the Government or any department thereof since October, 1911, to go to Hudson's Bay or James Bay; the name of each and the tonnage; the name and residence of each commanding officer; what cargo each carried, and what portion was landed, and where, what was lost and where, and what returned; with the values in each case. Presented 8th March, 1915.—*Mr. Graham.* . . . .*Not printed.*

148a. Return to an Order of the House of the 3rd March, 1915, for a return showing the number of ships employed by the Railway Department, the number of men hired on vessels and on shore, and the amount expended for supplies, men and transportation from 31st March, 1914, to 31st December, 1914, in connection with the Hudson Bay Railway expenditures. Presented 22nd March, 1915.—*Mr. Macdonald.* .*Not printed.*

149. Return to an Address to His Royal Highness the Governor General, of the 9th February, 1914, for a copy of all correspondence since the 1st January last with regard to the calling of an Imperial Conference on the subject of naval defence. Presented 8th March, 1915.—*Sir Wilfrid Laurier.* . . . .*Not printed.*

CONTENTS OF VOLUME 28—*Continued.*

150. Return to an Order of the House, of the 11th February, 1915, for a return showing the names and addresses of all persons in Antigonish County to whom the bounty under the Fenian Raid Volunteer Bounty Act has been paid; the names and addresses of all persons from said county whose applications have been rejected, and a list giving names and addresses of all applications from said county whose applications have not yet been disposed of. Presented 8th March, 1915.—*Mr. Chisholm (Antigonish).* *Not printed.*

151. Return to an Order of the House, of the 3rd March, 1915, for a return showing:—1. Who were the different officers commissioned to the 17th Nova Scotia Regiment at Valcartier before they sailed for England? 2. Who are now the commissioned officers of said regiment. Presented 8th March, 1915.—*Mr. Macdonald*.. .. ..*Not printed.*

152. Return to an Order of the House, of the 9th February, 1915, for a copy of all accounts of the transfer of the storm signal at Shippigan, N.B., from its former position on land to the public wharf, showing the total cost of said transfer during the months of October and November in 1911. Presented 8th March, 1915.—*Mr. Turgeon.* *Not printed.*

153. Return to an Order of the House, of the 4th May, 1914, for a copy of all correspondence, telegrams, petitions, including the signatures of such petitions, and all other documents and papers in the possession of the Department of Trade and Commerce, or the minister of said department, or in the possession of the Prime Minister, relating to any application made between 1st November, 1913, and date hereof by parties in Nova Scotia asking for Government assistance towards the transportation of fresh fish between ports in Nova Scotia and the United States. Presented 9th March, 1915.—*Mr. Sinclair.* *Not printed.*

154. Statement of Mr. H. C. Crowell, staff correspondent of the Halifax *Chronicle*, and correspondence in connection with statements appearing in the press referring to alleged ill-treatment of the 17th Regiment of Nova Scotia, at Salisbury Plains. Presented by Sir Robert Borden, 9th March, 1915.. .. ..*Not printed.*

155. Return to an Order of the House, of the 3rd March, 1915, for a return showing:—1. The estimated cost of fitting up the works of the Canadian Car and Foundry Company, Limited, at Amherst, N.S., for military purposes. 2. The rent or other remuneration being paid, or will be paid, this company for the use of its buildings. 3. Who are to supply the military provisions, including food for men, coal for heating and cooking, and food and other supplies for horses quartered on these premises, and at what prices. 4. Whether it is true that forms for tendering for such military supplies could only be obtained from the office of the sitting member for Cumberland County, and in several cases forms of tender were refused to applicants. 5. Whether the Government is aware that in the case of the supplying of hay, as alleged, not only Liberals were not allowed to tender for same, but supporters of the Government were informed they would not secure any part of the contract, if any of the hay to be supplied was to be purchased from a Liberal. Presented 11th March, 1915.—*Mr. Copp*.. .. ..*Not printed.*

156. Return to an Address to His Royal Highness the Governor General, of the 1st March, 1915, for a copy of all correspondence of the Imperial authorities on the subject of loans from the Imperial Treasury to the Canadian Government. Presented 11th March, 1915.—*Mr. Maclean (Halifax)*.. .. ..*Not printed.*

157. Return to an Order of the House of the 3rd March, 1915, for a copy of all correspondence, recommendations, letters and telegrams relating to the appointment of H. W. Ingraham as Assistant Registrar of Alien Enemies at Sdyney, N.S., and to his dismissal from the said office. Presented 12th March, 1915.—*Mr. Kyte*.. .. ..*Not printed.*

158. Return to an Address to His Royal Highness the Governor General of the 11th February, 1915, for a copy of all correspondence relating to the purchase of, and payment by the Government for two submarines authorized by Order in Council dated the 7th August, 1914, and of any other Order or Orders in Council relating thereto; and also of all reports received by the Government or any department thereof referring to said submarines. Presented 12th March, 1915.—*Mr. Pugsley* .. ..*Printed for distribution only.*

158a. Supplementary Return to an Address to His Royal Highness the Governor General, of the 11th February, 1915, for a copy of all correspondence relating to the purchase of, and payment by the Government for two submarines authorized by Order in Council dated the 7th August, 1914, and of any other Order or Orders in Council relating thereto; and also of all reports received by the Government or any department thereof referring to said submarines. Presented 15th March, 1915.—*Mr. Pugsley.* *Printed for distribution only.*

CONTENTS OF VOLUME 28—*Continued.*

158*b*. Further Supplementary Return to an Address to His Royal Highness the Governor General, of the 11th February, 1915, for a copy of all correspondence relating to the purchase of, and payment by the Government for two submarines authorized by Order in Council dated the 7th August, 1914, and of any other Order or Orders in Council relating thereto; and also of all reports received by the Government, or any department thereof, referring to said submarines. Presented 24th March, 1915.—*Mr. Pugsley.* *Printed for distribution only.*

159. Return to an Order of the House of the 19th February, 1915, for a copy of all correspondence, telegrams, petitions, letters and all other documents in any way referring to the dismissal of Mr. Mallet, captain of the life-boat in the life-saving station at Cheticamp, and the appointment of his successor. Presented 12th March, 1915.—*Mr. Chisholm (Antigonish)*.. .. ..*Not printed.*

160. Return to an Order of the House of the 3rd March, 1915, for a copy of all letters, papers and other documents relating to the discharge of Dr. John McKenzie as medical doctor to the Indians of Pictou County, and to the appointment of Dr. Keith as his successor. Presented 12th March, 1915.—*Mr. Macdonald*.. .. ..*Not printed.*

161. Return to an Order of the House of the 15th February, 1915, for a copy of all correspondence, letters, telegrams, instructions, reports and other documents relating to an application by Udo F. Schrader for a grazing lease in townships 40 and 41, range 7, west of the 3rd meridian, province of Saskatchewan. Presented 12th March, 1915.—*Mr. McCraney*.. .. ..*Not printed.*

162. Return to an Order of the House of the 3rd March, 1915, for a return showing the names of all applicants for Fenian Raid Bounty in the county of Pictou who have not yet been paid their bounty. Presented 15th March, 1915.—*Mr. Macdonald*.. ..*Not printed.*

162*a*. Return to an Order of the House of the 19th February, 1915, for a return showing the names and addresses of all persons in the county of Pictou who have been paid the Fenian Raid Bounty, and of all persons in said county who have made application for said bounty, and who have not yet received it. Presented 15th March, 1915.—*Mr. Macdonald*.. .. ..*Not printed.*

163. Return to an Order of the House of the 4th March, 1915, for a return showing:—1. From whom food for men and horses, and all other supplies and equipment for the Field Battery now being trained at Lethbridge, is bought? 2. If by tender, the date tenders were called for? 3. When tenders were opened and contracts awarded? 4. The names and post office addresses of all parties who submitted tenders? 5. The successful tenderers, and the price in each case. Presented 15th March, 1915.—*Mr. Buchanan*.. .. ..*Not printed.*

164. Return to an Order of the House, of the 1st March, 1915, for a copy of all petitions, reports, recommendations, letters, telegrams and correspondence relating to the dredging of Antigonish Harbour and the opening or improving of the entrance thereto, received by the Government, or any department thereof, since the 1st January, 1912, and not already included in the return presented the 30th of April, 1914, in obedience to the Order of the House passed the 16th March, previously. Presented 15th March, 1915.—*Mr. Chisholm (Antigonish)*.. .. ..*Not printed.*

165. Copy of Order in Council dated 9th March, 1915, restricting the transfer of British ships. Presented by Hon. Mr. Hazen, 16th March, 1915.. .. ..*Not printed.*

166. Report of the Commissioners appointed to investigate and report upon the water levels of the River St. Lawrence at and below Montreal, together with a brief summary prepared by the Chief Hydrographer of the Survey. Presented by Hon. Mr. Hazen, 16th March, 1915.. .. ..*Not printed.*

167. Return to an Order of the House of the 3rd March, 1915, for a copy of all letters, telegrams, papers and other documents relating to the mail contract between Chance Harbour and Trenton, Pictou County, in regard to the existing contract. Presented 18th March, 1915.—*Mr. Macdonald*.. .. ..*Not printed.*

168. Return to an Order of the House of the 19th February, 1915, for a copy of all correspondence and other documents relating to the awarding of the mail contract at Maria Capes, Bonaventure County, in 1914. Presented 18th March, 1915.—*Mr. Marcil.* *Not printed.*

169. Return to an Order of the House of the 15th February, 1915, for a copy of all tenders letters and telegrams, including first and second call for tenders, for rural mail delivery in the township of Dundee, county of Huntingdon. Presented 18th March, 1915.—*Mr. Robb*.. .. ..*Not printed.*

CONTENTS OF VOLUME 28—*Continued.*

170. Return to an Order of the House of the 11th February, 1915, for a copy of all petitions, letters, telegrams and correspondence regarding a proposed daily mail service between Lower South River and South Side Harbour, Antigonish County, and improved postal accommodation for the residents of the last-named district. Presented 17th March, 1915.—*Mr. Chisholm* (*Antigonish*) . . . . *Not printed.*

171. Return to an Order of the House of the 1st March, 1915, for a copy of all letters, documents, telegrams, recommendations, petitions and other papers received by the Post Office Department since 1st January, 1914, relating to the contract for carrying the mails between Guysborough and Canso, N.S. Presented 18th March, 1915.—*Mr. Sinclair* . . . . *Not printed.*

172. Return to an Order of the House of the 22nd February, 1915, for a return showing 1. The total number of employees, both permanent and temporary, at the following post offices: Montreal, Toronto, Winnipeg, Halifax, Quebec, St. John, N.B., and Vancouver. 2. The total amount of salaries paid in each case. 3. The total number of employees, and the amount of salaries paid in the above offices on the 1st of October, 1911. Presented 18th March, 1915.—*Mr. Lemieux* . . . . *Not printed.*

173. Return to an Order of the House of the 19th February, 1915, for a copy of all correspondence, telegrams, letters, petitions and documents of all kinds in any way referring to a proposed change in the mail route from Inverness railway station to Margaree Harbour. Presented 18th March, 1915.—*Mr. Chisholm* (*Inverness*) . . . . *Not printed.*

174. Return to an Order of the House of the 8th March, 1915, for a return showing:—1. From how many firms or individuals the Government, or any department thereof, has ordered soldiers uniforms since the 1st of July, 1914. 2. The names of these firms. 3. How many Oliver equipments have been ordered from each firm. 4. How many of these uniforms each firm has delivered up to date. 5. How many each firm has yet to deliver. 6. The price each firm is receiving for these uniforms. Presented 18th March, 1915.—*Mr. Murphy* . . . . *Not printed.*

175. Return to an Order of the House of the 8th March, 1915, for a return showing:—1. From how many firms or individuals the Government, or any department thereof, has ordered Oliver equipments since the 1st of July, 1914? 2. The names of these firms? 3. How many Oliver equipments have been ordered from each firm? 4. How many each firm has delivered up to date? 5. How many each firm has yet to deliver? 6. The price each firm is receiving for these Oliver equipments? Presented 18th March, 1915.—*Mr. Murphy* . . . . *Not printed.*

176. Return to an Order of the House of the 11th March, 1915, for a copy of all letters, correspondence, etc., relating to the appointment of William Gore Foster, of Dartmouth, N.S., to the position of Inspector of Indian Reserves. Presented 18th March, 1915.—*Mr. Carroll* . . . . *Not printed.*

177. Return to an Order of the House of the 15th February, 1915, for a copy of all letters, telegrams, correspondence, leases, and other documents relating to the cutting of lumber by Mr. B. F. Smith, and others, from the so-called Tobique Indian Reserve in the province of New Brunswick since the twelfth day of March, A.D. 1914, and also of all agreements, offers and promises made either by the said B. F. Smith or the Department of Indian Affairs, with reference to the sale or disposal of any of the said Tobique Indian Reserve since the said date, or any logs or lumber cut thereon. 2. Also a statement of all lumber cut by the said B. F. Smith from the said reserve, the rates of stumpage charged, and the amounts actually paid thereon from the first day of January, 1912, down to the date hereof. Presented 18th March, 1915.—*Mr. Carvell.* *Not printed.*

178. Return to an Order of the House of the 8th March, 1915, for a return showing:—1. The number of customs officers employed at the customs port of Masonville, Quebec, on 20th September, 1911. 2. The names of these officers. 3. The salary each one received. 4. The total amount of salaries paid the officers at this port. 5. The number of customs officers employed at the port of Masonville at the present time. 6. The names of these officers. 7. The salary each one receives. 8. The total amount of salaries paid to the officers at this port. Presented 18th March, 1915.—*Mr. Kay* . . . . *Not printed.*

179. Return to an Order of the House of the 8th March, 1915, for a return showing:—1. The number of customs officers employed at the customs port of Highwater, Quebec, on 20th September, 1911. 2. The names of these officers. 3. The salary each one received. 4. The total amount of salaries paid the officers at this port. 5. The number of customs officers employed at the port of Highwater at the present time. 6. The names of these officers. 7. The salary each one receives. 8. The total amount of salaries paid to the officers at this port. Presented 18th March, 1915.—*Mr. Kay* . . . . *Not printed.*

CONTENTS OF VOLUME 28—*Continued.*

180. Return to an Order of the House of the 8th March, 1915, for a return showing:—1. The number of customs officers employed at the customs port of Abercorn, Quebec, on 20th September, 1911. 2. The names of these officers. 3. The salary each one received. 4. The total amount of salaries paid the officers at this port. 5. The number of customs officers employed at the port of Abercorn at the present time. 6. The names of these officers. 7. The salary each one receives. 8. The total amount of salaries paid to the officers at this port. Presented 18th March, 1915.—*Mr. Kay*... ..*Not printed.*

181. Return to an Order of the House, of the 1st March, 1915, for a copy of all petitions, letters, communications and other documents relating to or bearing upon the dismissal of Leonard Hutchinson, chief keeper at Dorchester penintentiary. Presented 18th March, 1915.—*Mr. Copp*.. .. ..*Not printed.*

182. Return to an Order of the House of the 22nd February, 1915, for a copy of all letters, telegrams and papers generally concerning the proposed construction of a bridge to connect Isle Perrot with the mainland at Vaudreuil. Presented 18th March, 1915.—*Mr. Boyer*... .. ..*Not printed.*

182*a*. Return to an Order of the House of the 22nd February, 1915, for a copy of all letters, telegrams and papers generally concerning the proposed construction of a bridge between the Island of Montreal and the Mainland at Vaudreuil. Presented 18th March, 1915.—*Mr. Boyer* .. ..*Not printed.*

183. Return to an Order of the House of the 22nd February, 1915, for a return showing:—1. What properties have been acquired by the Government in the City of Regina since 21st September, 1911? 2. The descriptions of such properties by metes and bounds? 3. For what purposes such properties were acquired? 4. From whom such properties were purchased? 5. The total price and the price per foot paid for each property? 6. If any such property was acquired by expropriation, what tribunal determined the price to be paid for any property so expropriated? 7. The dates on which any such properties were acquired? Presented 18th March, 1915.—*Mr. Martin (Regina).*

184. Return to an Order of the House of the 19th February, 1915, for a copy of all letters, telegrams, memoranda, pay-lists, recommendations and any other documents whatsoever in any wise appertaining to the construction of a wharf at Lower Burlington, in the County of Hants. Presented 18th March, 1915.—*Mr. Chisholm (Inverness).* *Not printed.*

185. Return to an Order of the House of the 24th February, 1915, for a copy of pay-rolls and all correspondence and vouchers in connection with the repairs to Jordan breakwater, Shelburne county, for which Leander McKenzie was contractor of works or foreman. Presented 18th March, 1915.—*Mr. Law* .. ..*Not printed.*

186. Return to an Order of the House of the 24th February, 1915, for a copy of all letters, telegrams, correspondence and pay-rolls in connection with repairs and extension of breakwater at Bluff Head, Yarmouth county, N.S., during year 1914. Presented 18th March, 1915.—*Mr. Law*.. .. ..*Not printed.*

187. Return to an Order of the House of the 22nd February, 1915, for a return showing the amounts expended by the Public Works Department in the County of Inverness each year from 1896 down to 1915. Presented 18th March, 1915.—*Mr. Chisholm (Inverness)*.. .. ..*Not printed.*

188. Return to an Order of the House of the 24th February, 1915, for a copy of all letters, telegrams, correspondence and pay-sheets in connection with the repairs and other work on the breakwater at Sandford, Yarmouth County, N.S., during the year 1914. Presented 18th March, 1915.—*Mr. Law*.. .. ..*Not printed.*

189. Return to an Order of the House of the 1st March, 1915, for a copy of all papers, letters, petitions and other documents relating to a mail contract with David D. Heard & Sons, between Whitby and Grand Trunk Railway station, or with one John Gimblet, Whitby. Presented 19th March, 1915.—*Mr. Pardee*.. .. ..*Not printed.*

190. Copies of Reports of the Committee of the Privy Council, approved by His Royal Highness the Governor General, relating to certain advances made to the Canadian Northern Railway Company and the Grand Trunk Pacific Railway Company, respectively, together with copies of agreements made between the said companies and His Majesty. Presented by Hon. Mr. White, 19th March, 1915.. .. ..*Not printed.*

191. Return to an Order of the House of the 11th February, 1915, for a copy of all tenders received by the Post Office Department for the mail service between Caraquet and Tracadie, Gloucester County, N.B., on the 15th day of January last, with the names of the tenderers, the respective amounts of the tenders, and the name of the new contractor. Presented 19th March, 1915.—*Mr. Turgeon*.. .. ..*Not printed.*

CONTENTS OF VOLUME 28—*Continued.*

192. Return to an Order of the House of the 8th March, 1915, for a return showing:—1. The fractional areas of homestead lands or otherwise in the province of Saskatchewan sold in the year 1914. 2. The name of the purchaser, and the price paid in each case. Presented 22nd March, 1915.—*Mr. Martin (Regina)*... .. ..*Not printed.*

193. Return to an Order of the House of the 25th February, 1915, for a return showing, in reference to the answer to question No. 6 of 9th February, and answered 15th February as per page 161 unrevised *Hansard*, the cost of furnishing the Government offices in each of the said buildings. Presented 22nd March, 1915.—*Mr. Turriff.*
Not printed.

194. Return to an Order of the House of the 1st March, 1915, for a return showing the amount of railway subsidies paid in the county of Inverness since 1896, to date, and the dates on which such subsidies were paid. Presented 22nd March, 1915.—*Mr. Chisholm (Inverness)*.. .. ..*Not printed.*

195. Return to an Order of the House of the 1st March, 1915, for a copy of all letters, papers, telegrams and other documents relating to the purchase or lease of the railway from New Glasgow to Thorburn, in the county of Pictou, known as the Vale Railway, from the Acadia Coal Company, since January, 1911, to date. Presented 22nd March, 1915. —*Mr. Macdonald*.. .. ..*Not printed.*

196. Return to an Order of the House of the 1st March, 1915, for a copy of all papers, letters, telegrams, correspondence, contracts, etc., in connection with the sale of the hay grown or the lease of certain tracts of land belonging to the Intercolonial Railway, upon which hay is grown, and which are contiguous to the properties of Charles Lavoie, Cléophas Leclerc and Joseph Parent of the Parish of Bic, county of Rimouski. Presented 22nd March, 1915.—*Mr. Lapointe (Kamouraska)*.. .. ..*Not printed.*

197. Return to an Order of the House of the 3rd March, 1915, for a copy of all letters, papers, telegrams, evidence taken at investigations, reports and all other documents relating to the suspension or other action in regard to the charge of drunkeness against Newton Hopper, conductor on the Intercolonial Railway, and to his subsequent reinstatement. Presented 22nd March, 1915.—*Mr. Macdonald*.. .. ..*Not printed.*

198. Return to an Order of the House of the 1st March, 1915, for a copy of all letters, telegrams and other papers relating to the dismissal of Bruce Wiswell, as sectionman on the Intercolonial Railway at Stellarton, Nova Scotia. Presented 22nd March, 1915.—*Mr. Macdonald*.. .. ..*Not printed.*

199. Return to an Order of the House of the 22nd February, 1915, for a return showing:—1. The inward tonnage freight, and also the outward tonnage freight respectively, at Loggieville station of the Intercolonial Railway for each month of 1914, and also for the month of January, 1915. 2. The inward tonnage freight, and the outward tonnage freight at Chatham station, on the Intercolonial Railway for each month of 1914, and also for the month of January, 1915. 3. The inward tonnage freight, and the outward tonnage freight at Newcastle station on the Intercolonial Railway for each month of 1914, and also for the month of January, 1915. 4. The local and through passenger traffic to and through each of the above stations, respectively, during each of the months above mentioned. Presented 22nd March, 1915.—*Mr. Loggie.*
Not printed.

200. Return to an Order of the House of the 15th February, 1915, for a copy of all letters, telegrams and correspondence had by Margaret Lynch, or any person representing her, with reference to the expropriation of certain land beolnging to the said Margaret Lynch in the city of Fredericton, province of New Brunswick, by the Intercolonial Railway, and also of all letters, telegrams and correspondence had with F. P. Gutelius or any other official of the Intercolonial Railway with reference thereto. Presented 22nd March, 1915.—*Mr. Carvell*.. .. ..*Not printed.*

201. Return to an Order of the House of the 3rd March, 1915, for a copy of all documents bearing on the payment made to C. R. Scoles, New Carlisle, Quebec, in July, 1914, of balance of subsidy voted to the Atlantic and Lake Superior Railway on the recommendation of the Financial Comptroller. Presented 22nd March, 1915.—*Mr. Marcil*
Not printed.

202. Return to an Order of the House of the 1st March, 1915, for a copy of all letters, telegrams, correspondence and reports relating to the purchase of the New Brunswick and Prince Edward Island Railway, extending from Sackville to Cape Tormentine, county of Westmorland. Presented 22nd March, 1915.—*Mr. Copp*.. .. ..*Not printed.*

203. Return to an Order of the House of the 1st March, 1915, for a copy of the tariff on flour shipments now in force on the Quebec, Oriental Railway and the Atlantic, Quebec and Western Railway. Presented 22nd March, 1915.—*Mr. Marcil*.. .. ..*Not printed.*

CONTENTS OF VOLUME 28—*Continued.*

204. Return to an Order of the House of the 22nd February, 1915, for a copy of all petitions, correspondence, complaints, reports and other documents relating to the dismissal of Alfred H. Bonnyman, postmaster of Mattatall Lake, in the county of Colchester, N.S. Presented 24th March, 1915.—*Mr. Sinclair*.. .. ..*Not printed.*

205. Return to an Address to His Royal Highness the Governor General, of the 1st March, 1915, for a copy of all correspondence, documents, charges, evidence, findings and Orders in Council in reference to the dismissal of John Thomas, postmaster at Hammond's Plain, Halifax County, N.S. Presented 24th March, 1915.—*Mr. Maclean (Halifax)*.. .. ..*Not printed.*

205a Supplementary Return to an Address to His Royal Highness the Governor General, of the 1st March, 1915, for a copy of all correspondence, documents, charges, evidence, findings and Orders in Council in reference to the dismissal of John Thomas, postmaster at Hammond's Plain, Halifax County, N.S. Presented 8th April, 1915.—*Mr. Maclean (Halifax)*... .. ..*Not printed.*

206. Certified copy of a Report of the Committee of the Privy Council, approved by His Royal Highness the Governor General, with reference to the question of providing adequate pensionary assistance for officers and men disabled or partially disabled on active service or for the dependents of such officers and men should they be killed on active service. Presented by Sir Robert Borden, 24th March, 1915... .. .. *Not printed.*

207. Return to an Order of the House of the 8th March, 1915, for a return showing:—1. From how many firms or private individuals the Government, or any department of the Government has ordered saddles since the 1st of July, 1914? 2. The names of these firms? 3. How many saddles have been ordered from each firm? 4. How many saddles each firm has delivered up to date? 5. How many saddles each firm has yet to deliver? 6. The price each firm is receiving for these saddles? Presented 26th March, 1915.—*Mr. Murphy*.. .. ..*Not printed.*

208. Return to an Order of the House of the 8th March, 1915, for a copy of all correspondence, letters, telegrams and other documents relating to the dismissal of Mr. P. B. Hurlbert, postmaster at Springdale, Yarmouth County, N.S., and the removal of the office. Presented 30th March, 1915.—*Mr. Law*.. .. ..*Not printed.*

209 Return to an Order of the House of the 8th March, 1915, for a copy of all letters, petitions, telegrams and correspondence between the Hon. L. P. Pelletier, ex-Postmaster General and any person or persons of the county of Lévis, which during the month of April, 1912, had any connection with the appointment of G. A. Marois to a position in the customs office at Quebec, and the appointment of J. E. Gingras as postmaster of St. Romuald and Etchemin. Presented 30th March, 1915.—*Mr. Bourassa.* *Not printed.*

210. Return to an Order of the House of the 22nd February, 1915, for a copy of all letters, telegrams, petitions and documents of all kinds in possession of the Post Office Department, referring in any way to the conduct of the postmaster at Grand Etang since his appointment until the present date. Presented 30th March, 1915.—*Mr. Chisholm (Inverness)*.. .. ..*Not printed.*

211. Return to an Order of the House of the 1st March, 1915, for a copy of all telegrams, letters, papers, documents, evidence and reports, in connection with the dismissal of Charles H. Marshall as postmaster at Nanton, Alberta. Presented 30th March, 1915.—*Mr. Warwick*.. .. ..*Not printed.*

212. Return to an Order of the House of the 1st March, 1915, for a copy of the report of the officer in charge of the lobster hatchery at Port Daniel West, and of the report of the inspection thereof for the season 1914. Presented 31st March, 1915.—*Mr. Marcil.* *Not printed.*

213. Return to an Order of the House of the 24th February, 1915, for a copy of all correspondence, petitions, documents, etc., in connection with a petition of Donald Williams and others in respect to the regulation of fish traps in Green Harbour and vicinity. Presented 31st March, 1915.—*Mr. Law*.. .. ..*Not printed.*

214. Return to an Order of the House of the 9th February, 1915, for a copy of all correspondence, petitions, departmental recommendations and other papers and documents in the Department of Marine and Fisheries relating to the definition of a "coasting voyage," as defined in the Canada Shipping Act since the revision of the statutes in 1886. Presented 1st April, 1915.—*Mr. Sinclair*.. .. ..*Not printed.*

215. Return to an Order of the House of the 1st March, 1915, for a copy of all advertisements, tenders, contracts, vouchers, letters, documents, etc., relating to the establishment of the ferry service between the City of Halifax and Dartmouth, N.S., for the employees of the Marine and Fisheries Department at Halifax, N.S. Presented 1st April, 1915.—*Mr. Maclean (Halifax)*.. .. ..*Not printed.*

CONTENTS OF VOLUME 28—*Continued.*

216. Return to an Order of the House of the 24th February, 1915, for a copy of all pay-rolls, vouchers in detail, correspondence and all other documents in connection with the following public wharves in Shelburne; breakwater or wharf at East Green Harbour; shed on public wharf at Shelburne, and repairs to Gunning Cove wharf. Presented 1st April, 1915.—*Mr. Law* . . . . *Not printed.*

217. Return to an Order of the House of the 22nd February, 1915, for a return showing:—1. What properties have been acquired by the Government in the city of Regina since 21st September, 1911? 2. The descriptions of such properties by metes and bounds? 3. For what purposes such properties were acquired? 4. From whom such properties were purchased? 5. The total price and the price per foot paid for each property. 6. If any such property was acquired by expropriation, what tribunal determined the price to be paid for any property so expropriated. 7. The dates on which any such properties were acquired. Presented 1st April, 1915.—*Mr. Martin (Regina)* . . *Not printed.*

218. Return to an Order of the House of the 11th February, 1915, for a copy of all papers, letters, telegrams, etc., concerning the purchase of the property known as the Carslake Hotel, in Montreal, for post office purposes. Presented 1st April, 1915.—*Mr Lemieux.* *Not printed.*

219. Return to an Address to His Royal Highness the Governor General, of the 1st March, 1915, for a copy of all letters, telegrams, reports, recommendations, Orders in Council, pay-rolls, list of expenditures, names of foremen and superintendents, and all other documents whatsoever relating to or in anywise appertaining to the erection and maintaining of breakwaters at Phinney's Cove and Young's Cove, county of Annapolis. Presented 1st April, 1915.—*Mr. Macdonald* . . . . *Not printed.*

220. Return to an Order of the House of the 24th February, 1915, for a copy of all correspondence, petitions and documents since the 31st of October, 1912, relating in any way whatever to the proposed public wharf at Lower Wood Harbour. Presented 1st April, 1915.—*Mr. Law* . . . . *Not printed.*

221. Return to an Order of the House of the 1st March, 1915, for a copy of all advertisements, tenders, accounts, vouchers, letters, documents and correspondence relating to the construction of an extension to the breakwater at Prospect, Halifax County, N.S. Presented 1st April, 1915.—*Mr. Maclean (Halifax)* . . . . *Not printed.*

222. Return to an Order of the House of the 1st March, 1915, for a copy of all telegrams, letters, petitions, reports, recommendations and documents of all kinds in any way referring to the purchase of a site for a public building at Port Hawkesbury, and also referring in any way to the erection of a public building thereon. Presented 1st April, 1915.—*Mr. Chisholm (Inverness)* . . . . *Not printed.*

223. Return to an Order of the House of the 8th March, 1915, for a return showing all amounts of money expended upon public works in the counties of Wright, Pontiac and Labelle from October, 1911, to date. Presented 1st April, 1915.—*Mr. Devlin.* *Not printed.*

224. Return to an Order of the House of the 17th March, 1915, for a copy of the pay-sheet for the month of October, 1914, in connection with repairs to the breakwater at Shippigan Gully, Gloucester County, N.B. Presented 1st April, 1915.—*Mr. Turgeon.* *Not printed.*

225. Return to an Order of the House of the 8th March, 1915, for a return showing:—1. From how many firms or private individuals the Government, or any department of the Government, has ordered bicycles since the 1st of July, 1914? 2. The names of these firms? 3. How many bicycles have been ordered from each firm? 4. How many each firm has delivered up to date? 5. How many each firm has yet to deliver? 6. The price each firm is receiving for these bicycles. Presented 1st April, 1915.—*Mr. Kyte* . . . . *Not printed.*

226. Return to an Order of the House of the 22nd February, 1915, for a return showing the names and addresses of all Fenian Raid Veterans in the county of Inverness who have been paid the Fenian Raid Bounty, the names and addresses of those who have not been paid, and the names and addresses of those whose applications have been refused. Presented 1st April, 1915.—*Mr. Chisholm (Inverness)* . . . . *Not printed.*

227. Return to an Order of the House of the 8th March, 1915, for a return showing:—1. From how many firms or private individuals the Government, or any department of the Government, has ordered motor cycles since the 1st of July, 1914? 2. The names of these firms? 3. How many motor cycles have been ordered from each firm? 4. How many each firm has delivered up to date? 5. How many each firm has yet to deliver? 6. The price each firm is receiving for these motor cycles? Presented 1st April, 1915. *Mr. Chisholm (Antigonish)* . . . . *Not printed.*

CONTENTS OF VOLUME 28—*Continued.*

228. Return to an Address to His Royal Highness the Governor General of the 19th February, 1915, for a copy of all Orders in Council, letters and telegrams exchanged between the Dominion Government and the several provinces, concerning the proposed transfer of fisheries in tidal waters from the Provincial to the Federal control. Presented 1st April, 1915.—*Mr. Lemieux*.. .. ..*Not printed.*

229. Return to an Order of the House of the 4th March, 1915, for a copy of all correspondence exchanged between the Government of Canada, or any minister or official thereof, in regard to the control of fisheries in Quebec province, as well as of all documents bearing on that question, together with a list of licenses granted by either Governments for the present year. Presented 1st April, 1915.—*Mr. Marcil*.. .. ..*Not printed.*

230. Return to an Order of the House of the 24th February, 1915, for a copy of all correspondence, letters, telegrams and petitions relating to the appointment of Alfred Bishop as farm foreman, or in any other capacity at the experimental station at Kentville, Nova Scotia. Presented 1st April, 1915.—*Mr. Kyte*.. .. ..*Not printed.*

231. Return to an Address of the 10th March, 1915, showing copies of all correspondence, telegrams and documents exchanged between the Department of Marine and Fisheries and the Minister of the Naval Service and the Department of Colonization, Mines and Fisheries of the province of Quebec, relating to the rescinding of the prohibition of net fishing in the waters of the Lakes of Two Mountains, St. Francis and St. Louis, as per Order in Council (197) passed in Ottawa, Thursday, 28th day of January, 1915.—*Senate*).. .. .. *Not printed.*

232. Return to an Order of the House of the 1st March, 1915, for a copy of all papers, letters, petitions and other documents relating to the establishment of a rural mail route from River John to Hedgeville, county of Pictou. Presented 3rd April, 1915.—*Mr. Macdonald.*
Not printed.

233. A communication from the Consul General of Belgium in Canada, respecting the protest of the Belgium Government against the contention of the German Chancery that as far back as in 1906, Belgium had broken her own neutrality by the conclusion of an agreement with Great Britain. Presented by Sir Robert Borden, 5th April, 1915.
Printed for sessional papers.

234. Return to an Address of the Senate dated 11th March, 1915, showing:—1. How much wheat, oats and barley has the Dominion Government purchased in 1914 for seed to be distributed in the West, giving the amount of each kind? 2. Where is said grain stored, and what rate of storage is the Government paying on same? 3. How much did the Government pay per bushel for oats, barley and wheat, purchased for said provinces, and when was said grain purchased? 4. Have they given a contract for cleaning said grain, and to whom, and at what price?—(*Senate*).. .. .. ..*Not printed.*

235. Return to an Order of the Senate dated the 18th March, 1915, that an Order of the Senate do issue for:—1. A return showing the results per grade of all grain in each of the terminal elevators at Fort William and Port Arthur at the annual weigh-up for each of the years 1912, 1913 and 1914. 2. A return showing the balances whether overages or shortages in each grade in each elevator for each of the said years. 3. A return showing the net result of the three years operations of each of said elevators in overages or shortages in each grade.—(*Senate*).. .. ..*Not printed.*

236. Return to an Order of the House of the 8th March, 1915, for a return showing:—1. The quantity of spirituous liquors, proof gallons, including ale, wines and beers, taken out of bond between 6th August and 21st August, 1914, at each port of the Dominion. 2. The quantity of cigars, cigarettes and tobacco taken out of bond between the above mentioned dates at each port of the Dominion. Presented 7th April, 1915.—*Mr. Hughes* (*Kings, P.E.I.*).. .. ..*Not printed.*

237. Return to an Order of the House of the 8th March, 1915, for a return showing:—1. From how many firms or private individuals the Government, or any department of the Government, has ordered forage caps since the 1st of July, 1914? 2. The names of these firms? 3. How many forage caps have been ordered from each firm? 4. How many each firm has delivered to date? 5. How many each firm has yet to deliver? 6. The price each firm is receiving for these forage caps? Presented 7th April, 1915.—*Mr. Murphy*.. .. ..*Not printed.*

238. Return to an Order of the House of the 11th March, 1915, for a copy of the report of Dr. Wm. Wakeham, on the extent of the losses sustained in the Baie des Chaleurs and Gulf of St Lawrence in the storm of 5th June, 1914, together with a statement showing the number of claims received and those entertained, with names of claimants and their residence, and the amounts paid to each, together with a copy of other documents bearing on this question. Presented 7th April, 1915.—*Mr. Marcil*.. .. ..*Not printed.*

CONTENTS OF VOLUME 28—*Continued.*

239. Return to an Address to His Royal Highness the Governor General, of the 23rd February, 1915, for a copy of all letters, telegrams, reports, recommendations, Orders in Council and all other documents and papers in connection with rewards to the officers and crews of steamers *John L. Cann* and *Westport III*, for their heroic efforts in saving the passengers and crews of ss. *Cobequid*, wrecked on Trinity Lodge, 13th January, 1914. Presented 7th April, 1915.—*Mr. Law* . . . . *Not printed.*

240. Return to an Order of the House of the 29th March, 1915, for a copy of all documents, letters, telegrams, reports, etc., relating to the dismissal of Alexandre Blais, of the city of Lévis, from the position of customs officer at Bradore Bay, and the appointment of his successor or successors. Presented 7th April, 1915.—*Mr. Bourassa* . . . *Not printed.*

241. A Return to an Address of the Senate dated 18th March, 1915, for:—1. A return showing all appointments to the Civil Service, Department of the Interior, in that area contained in the present constituencies of Medicine Hat and Macleod, giving names, date of appointment, how appointed, and salaries from the year 1896 to the present date. 2. Also, all vacancies by death, resignation or dismissal, giving name, date, length of service and cause of dismissal in the same area and during the same period.—(*Senate*). *Not printed.*

242. Return to an Order of the House of the 1st March, 1915, for a copy of charges made against J. Herbert Sweetman, customs officer at Port Daniel Centre, Quebec, which brought about his dismissal; and also of charges against Velson Horie, lighthouse keeper at Port Daniel West, Quebec, which brought about his dismissal. Presented 8th April, 1915.—*Mr. Marcil (Bonaventure)* . . . . *Not printed.*

243. Return to an Order of the House of the 22nd February, 1915, for a copy of all correspondence, recommendations, petitions, contracts, tenders and other papers and documents in any way connected with the letting of the contract for carrying the mails between Guysborough and Erinville, N.S. Presented 8th April, 1915.—*Mr. Sinclair*. *Not printed.*

244. Return to an Order of the House of the 10th March, 1915, for a copy of all reports, petitions, letters, telegrams and other documents in connection with the dismissal of W. M. Thomson from the postmastership at Fort Qu'Appelle, and of any petition or petitions for his reinstatement, and of all correspondence in connection therewith. Presented 8th April, 1915.—*Mr. Thomson (Qu'Appelle)* . . . . *Not printed.*

245. Return to an Order of the House of the 22nd March, 1915, for a copy of all letters, telegrams, correspondence and petitions received in the Post Office Department, in any way referring to the calling of tenders for the Antigonish-Sherbrooke mail service, which tenders were opened or due at the Post Office Department on the 11th December last; and of all representations or requests, recommending or suggesting that new tenders should be invited as was done early in February last. Presented 8th April, 1915. —*Mr. Chisholm (Inverness)* . . . . *Not printed.*

246. Return to an Order of the House of the 3rd March, 1915, for a copy of all letters, telegrams, papers and other documents in regard to a proposed rural mail delivery service between Pictou and Saltsprings, Pictou county, and as to the arrangements for the existing service between those points. Presented 8th April, 1915.—*Mr. Macdonald*. *Not printed.*

247. Return to an Address of His Royal Highness the Governor General, of the 1st March, 1915, for a copy of all letters, telegrams, reports, recommendations, Orders in Council, and all other documents and papers whatsoever relating to or in any wise connected with the establishment of rural mail routes and deliveries from Bridgetown to Granville Ferry, county of Annapolis, and especially of all letters, telegrams, reports, recommendations and documents relating to the closing of the post offices at Belleisle, Upper Granville, and the establishment of the post office at Granville Centre, all in the county of Annapolis. Presented 8th April, 1915.—*Mr. Macdonald* . . . . *Not printed.*

248. Return to an Order of the House of the 22nd February, 1915, for a copy of all telegrams, letters, reports, petitions and all other documents in any way referring to the proposed line of railway from Orangedale to Cheticamp. Presented 9th April, 1915.—*Mr. Chisholm (Inverness)* . . . . *Not printed.*

249. Return to an Order of the House of the 11th March, 1915, for a copy of all documents, investigations, reports, correspondence, etc., relating to the burning of certain buildings belonging to the Trois Pistoles Pulp and Lumber Company and to André Leblond, near Tobin station, on the Intercolonial Railway. Presented 9th April, 1915.—*Mr. Lapointe (Kamouraska)* . . . . *Not printed*

250. Return to an Order of the House of the 18th March, 1915, for a return showing the names of all officials, assistants and clerks, employed in the railway offices at Moncton, N.B., and the salary paid to each; also the names of officials formerly employed in said offices who have been retired on superannuation allowance, and the amount of retiring allowance being paid to each. Presented 9th April, 1915.—*Mr. Copp* . . . *Not printed.*

CONTENTS OF VOLUME 28—*Continued.*

251. Return to an Order of the House of the 24th March, 1915, for a return showing the names of all persons from whom lands have been purchased, the quantity of land so acquired, and the amount paid therefor, in connection with the Dartmouth and Dean's Post Office Branch of the Intercolonial Railway since the date of return numbered 128 made to Parliament at the last regular session thereof. Presented 9th April, 1915.—*Mr. Maclean (Halifax)*.. .. ..*Not printed.*

252. Return to an Address to His Royal Highness the Governor General of the 17th March, 1915, for a copy of all correspondence, letters, Orders in Council, agreements, etc., in reference to the leasing or transfer of the Windsor Branch of the Intercolonial Railway to the Canadian Pacific Railway. Presented 9th April, 1915.—*Mr. Maclean (Halifax). Not printed.*

253. Return to an Order of the House of the 22nd February, 1915, for a copy of all petitions, correspondence, reports of engineers or other persons in the possession of the Department of Railways and Canals relating to the construction of a railway in the county of Guysborough, N.S. Presented 9th April, 1915.—*Mr. Sinclair*.. .. .. ..*Not printed.*

254. Return to an Order of the House of the 10th March, 1915, for a copy of all letters and correspondence, between D. McDonald, superintendent of the Intercolonial, at Lévis, P. Brady, general superintendent at Moncton, or any other official of the said Intercolonial Railway and Théophile Bélanger, commercial traveller of the city of Montreal, concerning certain claims made by the said Théophile Bélanger for delay of baggage in transportation between Drummondville and Matapedia, in May, 1913, also all reports made bearing upon such claims against the said Intercolonial Railway. Presented 9th April, 1915.—*Mr. Ethier*.. .. ..*Not printed.*

255. Return to an Order of the House of the 15th February, 1915, for a copy of all letters, telegrams, minutes of investigation and other documents relating to the dismissal of Isaac Arbuckle, foreman carpenter Intercolonial Railway at Pictou, and of appointment of Alex. Talbot to the vacancy. Presented 9th April, 1915.—*Mr. Macdonald. Not printed.*

256. Return to an Order of the House of the 15th February, 1915, for a copy of all correspondence letters, telegrams, by any and all persons whomsoever, had with the Department of Railways and Canals, or F. P. Gutelius, general manager of the Intrcolonial Railway, or any other official thereof, with reference to freight rates over that portion of the Transcontinental Railway, province of New Brunswick, and also with reference to the removal of the Y connection at Wapski, county of Victoria, between the said Transcontinental Railway and the Canadian Pacific Railway at that point. Presented 9th April, 1915.—*Mr. Carvell* .. ..*Not printed.*

257. Return to an Order of the House of the 15th February, 1915, for a copy of all letters, telegrams, correspondence, contracts, and other documents relating to the operation of the St. John Valley Railway, so called, by the Intercolonial Railway, since the first day of July last past, and of all letters, correspondence, etc., had either with the Department of Railways and Canals, or with F. P. Gutelius, or any other official of the Intercolonial Railway. Presented 9th April, 1915.—*Mr. Carvell*.. .. ..*Not printed.*

258. Return to an Order of the House of the 1st March, 1915, for a copy of all petitions, memorials, letters, telegrams, communications and reports regarding the construction of a roadway to the new public wharf at Sackville, N.B., and also in regard to the building of a spur line or siding from the Intercolonial Railway at Sackville to said wharf. Presented 9th April, 1915.—*Mr. Copp*... .. ..*Not printed.*

259. Return to an Order of the House of the 15th March, 1915, for a copy of all correspondence passing between any department of the Government and any official of the Government, or any other person, with respect to the placing of settlers on homesteads in the Duck Mountains Timber Reserve, and also of the evidence taken by Inspector Cuttle, of the Department of the Interior, in an investigation held by the said inspector with respect to the granting of entries for homesteads on the said timber reserve. Presented 9th April, 1915.—*Mr. Martin (Regina)*... .. ..*Not printed.*

260. Return to an Order of the House of the 8th March, 1915, for a return showing:—1. From how many firms or private individuals the Government, or any department of the Government, has ordered flannel shirts since the 1st of July, 1914? 2. The names of these firms? 3. How many flannel shirts have been ordered from each firm? 4. How many each firm has delivered up to date? 5. How many each firm has yet to deliver? 6. The price each firm is receiving for these flannel shirts? Presented 9th April, 1915.—*Mr. Carroll*.. .. ..*Not printed.*

260a Return to an Order of the House of the 8th March, 1915, for a return showing:—1. From how many firms or private individuals the Government, or any department of the Government, has ordered cotton shirts since the 1st of July, 1914? 2. The names of these firms? 3. How many cotton shirts have been ordered from each firm? 4. How many each firm has delivered up to date? 5. How many each firm has yet to deliver? 6. The price each firm is receiving for these cotton shirts? Presented 9th April, 1915. —*Mr. Chisholm (Antigonish)*.. .. ..*Not printed.*

CONTENTS OF VOLUME 28—*Continued.*

260*b*. Return to an Order of the House of the 8th March, 1915, for a return showing:—1. From how many firms or private individuals the Government or any department of the Government, has ordered service shirts since the 1st of July, 1914? 2. The names of these firms? 3. How many service shirts have been ordered from each firm? 4. How many each firm has delivered up to date? 5. How many each firm has yet to deliver? 6. The price each firm is receiving for these service shirts? Presented 10th April, 1915.—*Mr. Carroll*.. .. ..*Not printed.*

260 Return to an Order of the House of the 8th March, 1915, for a return showing:—1. From how many firms or private individuals the Government or any department of the Government, has ordered winter shirts since the 1st of July, 1914? 2. The names of these firms? 3. How many winter shirts have been ordered from each firm? 4. How many each firm has delivered up to date? 5. How many each firm has yet to deliver? 6. The price each firm is receiving for these winter shirts? Presented 12th April, 1915. *Mr. McKenzie*.. .. ..*Not printed.*

261. Return to an Order of the House of the 11th March, 1915, for a return showing:—1. What medical supplies or other materials have been purchased since 1st August, 1914, by the Government, or any department of the Government, from Mr. T. A. Brownlee, of Ottawa? 2. The quantities of goods purchased from him and the prices paid? 3. Whether the Government, or any? department of the Government, prepared a schedule of rates tos how what constitutes a fair and reasonable price for such goods purchased? 4. If so, if a careful check was made to see that a fair and reasonable price was charged? 5. The total value of the goods delivered up to date? 6. The total value of the goods which have been ordered from Mr. T. A. Brownlee, but which to this date have not been delivered? Presented 9th April, 1915.—*Mr. Kyte*.. .. .. ..*Not printed.*

262. Return to an Order of the House of the 8th March, 1915, for a return showing:—1. From how many firms or private individuals the Government, or any department of the Government, has ordered kit bags since the 31st of July, 1914? 2. The names of these firms? 3. How many kit bags have been ordered from each firm? 4. How many each firm has delivered up to date? 5. How many each firm has yet to deliver? 6. The price each firm is receiving for these kit bags? Presented 9th April, 1915.—*Mr. Kyte.* *Not printed.*

263. Return to an Order of the House of the 11th March, 1915, for a return showing:—1. What medical supplies or other materials have been purchased since 1st August, 1914, by the Government, or any department of the Government, from Mr. S. J. Stevenson, or the Waverley Pharmacy? 2. The quantities of goods purchased from him and the prices paid? 3. Whether the Government, or any department of the Government, prepared a schedule of rates to show what constitutes a fair and reasonable price for such goods purchased? 4. If so, if a careful check was made to see that a fair and reasonable price was charged? 5. The total value of the goods delivered by Mr. Stevenson, or Waverley Pharmacy, up to date? 6. The total value of the goods which have been ordered from Mr. S. J. Stevenson, or Waverley Pharmacy, but which to this date have not been delivered? Presented 9th April, 1915.—*Mr. Chisholm (Antigonish).* *Not printed.*

264. Return to an Order of the House of the 8th March, 1915, for a return showing:—1. From how many firms or private individuals the Government, or any department of the Government, has ordered suits of underwear since the 1st July, 1914? 2. The names of these firms? 3. How many suits of underwear have been ordered from each firm? 4. How many each firm has delivered up to date? 5. How many each firm has yet to deliver? 6. The price each firm is receiving for these suits of underwear? Presented 9th April, 1915.—*Mr. Law*.. .. ..*Not printed.*

265. Return to an Order of the House of the 11th March, 1915, for a return showing:—1. What medical supplies or other materials have been purchased since 1st August, 1914, by the Government, or any department of the Government, from Mr. W. B. McDonald, of Ottawa? 2. The quantities of goods purchased from him and the prices paid? 3. Whether the Government, or any department of the Government, prepared a schedule of rates to show what constitutes a fair and reasonable price for such goods purchased? 4. If so, if a careful check was made to see that a fair and reasonable price was charged? 5. The total value of the goods delivered by Mr. McDonald up to date? 6. The total value of the goods which have been ordered from Mr. McDonald, but which to this date have not been delivered? Presented 9th April, 1915.—*Mr. Carroll.* *Not printed.*

266. Report of Thomas R. Ferguson, commissioner appointed to investigate matters pertaining to the Blood Indian Reserve and the acquisition of certain Indian lands by Messrs. James A. Smart, Frank Pedley and William J. White, together with the evidence taken in the said investigation. Presented by Hon. Mr. Coderre, 10th April, 1915. *Not printed.*

CONTENTS OF VOLUME 28—*Continued.*

267. Return to an Order of the House of the 17th March, 1915, for a copy of all petitions, letters, documents, etc., between persons in the province of Nova Scotia and the Department of Trade and Commerce since 1st August last, with regard to Atlantic ocean freight rates on subsidized steamers or otherwise. Presented 10th April, 1915.—*Mr. Maclean (Halifax)*. . . . .*Not printed.*

268. Return to an Order of the House of the 22nd February, 1915, for a copy of the report of investigation held about 1st June, 1914, by T. R. Ferguson, as special commissioner, into the allotment of homesteads on the area cut out of the Riding Mountain Forest Reserve in the year 1908 or about that time. Presented 10th April, 1915.—*Mr. Cruise.* *Not printed.*

269. Copy of Order in Council dated 6th April, 1915.—Regulations in respect to steam trawlers clearing from ports on the Atlantic seaboard of Canada. Presented by Hon. Mr. Hazen, 10th April, 1915. . . . .*Not printed.*

270. Return to an Order of the House of the 15th February, 1915, for a copy of all tenders in connection with the supply of lumber to the Department of Militia for the training camps at Medicine Hat and Calgary, and of the invoices for the material supplied. Presented 12th April, 1915.—*Mr. Buchanan*. . . . .*Not printed.*

271. Return to an Order of the House of the 17th March, 1915, for a copy of all correspondence and reports relating to the purchase of 25,000 shovels of special pattern, mentioned in Order in Council P.C. 2302, dated 4th September, 1914, on page 38 of memoranda respecting work of the Department of Militia and Defence, and also relating to any further purchases of such shovels. Presented 12th April, 1915.—*Mr. Hughes (Kings, P.E.I.)*. . . . .*Not printed.*

272. Return to an Order of the House of the 15th March, 1915, for a return showing the names of the persons who bought the horses which were sold by auction at Valcartier camp, giving the price paid for each horse. Presented 12th April, 1915.—*Mr. Kay.* *Not printed.*

273. Return to an Order of the House of the 24th February, 1915, for a return showing:—1. If the Government ever leased any land at or near Shelburne, Nova Scotia, known as the Barracks property, to the town of Shelburne? 2. If, so, at what rental, and for how long? 3. If said lease is now in force? 4. If the Government has sold any of the standing timber on this property? 5. If so, when, to whom, and at what price? 6. How long the purchaser has to remove it? 7. What is the minimum size at the stump sold? 8. If the Government has ever had the property cruised by competent timber cruiser? 9. If so, by whom, and when? 10. If the timber on said property was advertised for sale, and if tenders were asked for, or any opportunity afforded to other prospective buyers to bid for this timber? 11. If any other offers were received? 12. If the town of Shelburne was notified before the sale took place. If so, on what date? 13. How much timber the Government estimates to be on this property? 14. What steps the Government intends to take to compute the quantity of timber cut from this property? 15. If the Government is aware that timber is now being cut from this property by a person or firm who are cutting timber from private property adjoining said Barracks property? 16. What steps are being taken by the Government to be sure that in this case the logs are kept separate from those coming from the adjoining lot, for the purpose of having accurate count and scale? 17. If the Government will bring down a copy of all correspondence, cruisers reports and contracts in relation to the sale of this timber? Presented 12th April, 1915.—*Mr. Law*. . . . . . .*Not printed.*

274. Return to an Address to His Royal Highness the Governor General, of the 11th February, 1915, for a copy of all correspondence, telegrams, Orders in Council, petitions and any other documents in connection with the removal of Edward N. Higinbotham from the position of postmaster at Lethbridge, Alberta. Presented 13th April, 1915.—*Mr. Buchanan*. . . . .*Not printed.*

275. Return to an Order of the House of the 10th March, 1915, for a copy of all petitions, correspondence and other documents in connection with the dismissal of Emile Cyr, postmaster at St. Hermas, county of Two Mountains. Presented 13th April, 1915.—*Mr. Ethier*. . . . .*Not printed.*

276. Return to an Order of the House of the 7th April, 1915, for a return showing:—1. Who the mail carriers are for the rural mail in the counties of Chicoutimi and Saguenay? 2. The salary of each such mail carrier, and the trip that each has to make? 3. Who the mail carriers are for the rural mails in the parishes of St. Prime and St. Louis de Metabetchouan, and their respective salaries? Presented 13th April, 1915.—*Mr. Lapointe (Kamouraska)*. . . . .*Not printed.*

277. Return to an Order of the House of the 29th March, 1915, for a copy of all documents, letters, telegrams, testimonials, reports, etc., relating to the claim of Télesphore Paradis, of the city of Lévis, arising from the burning of his wharf and mills which were set on fire by a locomotive of the Intercolonial Railway. Presented 13th April, 1915.—*Mr. Bourassa*. . . . .*Not printed.*

CONTENTS OF VOLUME 28—*Continued.*

278. Return to an Order of the House of the 8th April, 1915, for a return showing:—1. The number of employees connected with the administration of the Three Rivers post office on the 21st September, 1911, and the annual amount paid in salaries at that date for such service. 2. The number of employees connected with the administration of the Three Rivers post office at the present date, and the amount of the annual salaries paid for such service. 3. The number of employees in the Customs Department for Three Rivers on the 21st September, 1911, and the amount of the annual salaries paid for such service. 4. The number of employees in the Customs Department for Three Rivers at the present date, and the annual amount of the salaries paid for such service. 5. The number of employees in the Inland Revenue Department for the district of Three Rivers on the 21st September, 1911, and the annual amount of salaries paid for such service. 6. The number of employees at the present date in the Inland Revenue Department for the district of Three Rivers, and the amount of the annual salaries paid for such service. 7. The number of employees, and the amount paid in salaries for the works on the St. Maurice, in the county of Champlain, during the year 1911-12. 8. The number of employees, and the amount of salaries paid per year for the works on the St. Maurice, in the county of Champlain, since 1911-12. 9. If the employees whose names follow, were dismissed on the 26th and 27th November, 1914, and the 4th and 5th January, 1915; Wildé Lavalée, Pierre Thicierge, Joseph Paquin, sr., Joseph Paquin, jr., Athanase Célinas, clerks. 10. If so, at whose request, and for what reasons. 11. If those days were taken off the salaries of such employees. Presented 13th April, 1915.—*Mr. Bureau*.. .. .. *Not printed.*

279. Return to an Order of the House of the 4th March, 1915, for a copy of all documents bearing on the removal of the salmon retaining pond from Flat Lands to New Mills, N.B., and of all reports on the operations thereof, with a detailed statement of outlay and cost of removal, installation and operation. Presented 13th April, 1915.—*Mr. Marcil*.. .. .. *Not printed.*

280. Return to an Address to His Royal Highness the Governor General of the 3rd February, 1913, for a copy of all Orders in Council, letters, telegrams, reports, petitions and other papers and documents in the possession of the Department of Marine and Fisheries, or any department of the Government, relating to the granting of licenses to pack lobsters, and bearing date between 1st January, 1912, and 25th January, 1913. Presented 13th April, 1915.—*Mr. Sinclair*.. .. .. *Not printed.*

281. Report of Thomas R. Ferguson, K.C., commissioner appointed to investigate into all matters relating to, or connected with, the application for (although such application may not have been granted, or may still be pending) the sale, lease, grant, exchange, or other disposition by any means whatsoever, since the first day of July, 1896, of:—(a) Dominion Lands; (b) Timber and mineral lands and mining rights and privileges, including coal, petroleum, and gas lands and rights and irrigation tracts or lands, and the cutting of timber upon Government lands; (c) Water-power and rights; (d) Indian Lands and Indian Reserves: under authority or purporting to be under the authority of the Dominion Lands Acts, and Irrigation Act, or other statutes of the Parliament of Canada, and the acts or proceedings of any person or corporation in relation to the matters foresaid. Presented by Hon. Mr. Coderre, 13th April, 1915. *Not printed.*

282. Report and evidence upon the matter known as: "Timber Berths 550½ and 528, Howard Douglas, R. E. A. Leech, D. J. McDonald, and others." Presented by Hon. Mr. Coderre, 13th April, 1915.. .. .. *Not printed.*

283. Report and evidence upon the matter known as: "The Kananaskis Coal Company, Limited, Howard Douglas, George E. Hunter, Walter Garrett, and others." Presented by Hon. Mr. Coderre, 13th April, 1915.. .. .. *Not printed.*

284. Report and evidence upon the matter known as: "Blood Indian Reserve and Frank Pedley." Presented by Hon. Mr. Coderre, 13th April, 1915.. .. .. *Not printed.*

285. Report and evidence upon the matter known as: "Southern Alberta Land Company, Limited, and Grand Forks Cattle Company, J. D. McGregor, Arthur Hitchcock, and others." Presented by Hon. Mr. Coderre, 13th April, 1915.. .. .. *Not printed.*

286. Report and evidence upon the matter known as: "The Bulletin Company, Limited, the Honourable Frank Oliver, and the Grand Trunk Pacific Railway Company." Presented by Hon. Mr. Coderre, 13th April, 1915.. .. .. *Not printed.*

287. Report and evidence upon the matter known as: "Aylwin Irrigation Tract, E. A. Robert and J. D. McGregor." Presented by Hon. Mr. Coderre, 13th April, 1915...*Not printed.*

288. Report and evidence upon the matter known as: "Timber Berths 1107 and 1108, W. H. Nolan, A. W. Fraser, and J. G. Turiff." Presented by Hon. Mr. Coderre, 13th April, 1915.. .. .. *Not printed.*

CONTENTS OF VOLUME 28—*Continued.*

289. Report and evidence upon the matter known as: "Grazing Ranch No. 2422, J. G. Turriff, A. J. Adamson, and J. D. McGregor." Presented by Hon. Mr. Coderre, 13th April, 1915.. .. ..*Not printed.*

290. Report and evidence upon the matter known as: "Craven Dam, Walter Scott, Lieutenant-Governor Brown, and J. G. Turriff." Presented by Hon. Mr. Coderre, 13th April, 1915. *Not printed.*

291. Certified copies of Reports of the Committee of the Privy Council No. P.C. 1109 and No. P.C. 1589, approved by His Excellency the Administrator on the 10th May, 1913, and 27th June, 1913, respectively, in respect to the appointment of Thomas R. Ferguson, K.C., as commissioner to investigate and report upon all matters connected with the disposition by any means whatsoever, since the first day of July, 1896, of:—(a) Dominion Lands; (b) Timber and mineral lands and mining rights and privileges, including coal, petroleum, and gas lands and rights and irrigation tracts or lands, and the cutting of timber upon Government lands; (c) Water-power and rights. (d) Indian Lands and Indian Reserves. Presented by Sir Robert Borden, 13th April, 1915. *Not printed.*

292. Return to an Order of the House of the 11th March, 1915, for a copy of all charges, correspondence, letters, telegrams and other documents relative to the dismissal of Joseph Day, at Little Bras D'Or, in the riding of North Cape Breton and Victoria, and of the evidence taken and reports of the investigation held by H. B. Duchemin, in regard to same, with a detailed statement of expenses of such investigation. Presented 14th April, 1915.—*Mr. McKenzie*.. .. ..*Not printed.*

293. A Return to an Order of the Senate, dated 30th March, 1915, for a return giving the names of the trust companies up to the present date who have complied with the requirements of Clause 69 of the Trust Companies Act, 1914, and any correspondence connected therewith.—(*Senate*).. .. ..*Not printed.*

294. Report of R. A. Pringle, K.C., commissioner appointed to investigate into charges of corruption and fraud in relation to contracts for the building of certain drill halls in the province of Ontario, together with the evidence taken at the said inquiry. Presented by Sir Robert Borden, 14th April, 1915.. .. ..*Not printed.*

295. Return to an Order of the House of the 1st March, 1915:—1. For a full statement and description of all lands taken possession of by the Government for the camp at Valcartier. 2. For copies of all titles of the Government to the same, whether by expropriation, purchase or otherwise. 3. For a specified statement of all amounts claimed and still unpaid whether for land or damages. 4. For a specified account of all amounts paid up to date either for land or damages. Presented 15th April, 1915.—*Sir Wilfrid Laurier*.. .. ..*Not printed.*

296. A return to an Address to His Royal Highness the Governor General:—1. A return showing all appointments to the customs in that area contained in the present constituencies of Medicine Hat and Macleod, giving names, date of appointment, how appointed and salaries, from the year 1896 to the present date. 2. Also, all vacancies by death, resignation or dismissal, giving name, date, length of service and cause of dismissal in the same area and during the same period.—(*Senate*).. .. ..*Not printed.*

297. Return to an Address to His Royal Highness the Governor General; praying that His Royal Highness will cause to be laid before the Senate copies of all letters between the Minister of Marine and Fisheries or his department and the fishery overseer at Baker Lake, in the province of New Brunswick; and also copies of all claims made by the said fishery overseer and the payments made thereon.—(*Senate*).. .. *Not printed.*

SUMMARY REPORT

OF THE

GEOLOGICAL SURVEY

DEPARTMENT OF MINES

FOR THE CALENDAR YEAR

1914

PRINTED BY ORDER OF PARLIAMENT.

OTTAWA
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EXCELLENT MAJESTY
1915

[No. 26—1915] [No. 1503]

To Field Marshal, His Royal Highness Prince Arthur William Patrick Albert, Duke of Connaught and of Strathearn, K.G., K.T., K.P., etc., etc., etc., Governor General and Commander in Chief of the Dominion of Canada.

MAY IT PLEASE YOUR ROYAL HIGHNESS,—

The undersigned has the honour to lay before Your Royal Highness—in compliance with 6-7 Edward VII, chapter 29, section 18—the Summary Report of the operations of the Geological Survey during the calendar year 1914.

LOUIS CODERRE,
Minister of Mines.

To the Hon. Louis Coderre, M.P.,
Minister of Mines,
Ottawa.

Sir,—I have the honour to transmit, herewith, my summary report of the operations of the Geological Survey for the calendar year 1914, which includes the reports of the various officials on the work accomplished by them.

I have the honour to be, sir,
Your obedient servant,

R. G. McCONNELL,
Deputy Minister, Department of Mines.

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SUMMARY REPORT

OF THE

GEOLOGICAL SURVEY

DEPARTMENT OF MINES

FOR THE CALENDAR YEAR, 1914.

INTRODUCTORY STATEMENT.

The Summary Report covers the operations of all divisions of the Geological Survey for the calendar year 1914. Prominence is given to the economic features of work done by the staff during the year in order that new information secured may be given to the public in a preliminary way as early as possible.

Besides strictly geological work the Survey includes a Topographical division and divisions of Biology and Anthropology and administers the Victoria Memorial Museum.

PUBLICATION DIVISION.

Publications relating to the work accomplished in all of these divisions are issued from time to time, and it is the aim of the Geological Survey to make these available to all who are interested in them. To this end a notice list is kept on which applicants may have their names entered and receive notices of all publications issued, and so be in a position to send for any report desired. Following this procedure, 50,430 publications were distributed during the year 1914 in compliance with written and personal requests and 96,200 were sent to addresses on the regular mailing lists. In addition, French editions of the publications were distributed through the Publishing and Translating division of the department.

STAFF.

The following changes have taken place in the staff of the Survey during the year, 1914: R. W. Brock, Director, was appointed Deputy Minister of the Department January 1 and resigned November 30; R. G. McConnell, geologist, was appointed Deputy Minister of the Department, December 1. The following additional appointments were made: Merton Y. Williams, junior geologist; Bruce Rose, junior geologist; Harold C. Cooke, junior geologist; Wellman S. Hutton, assistant photographer; Claude E. Johnson, wax worker and colourist; Florence E. Forsey, cataloguer in Library; Edward E. Freeland, junior topographer; John R. Cox, junior topographer; Albert Cox, messenger; Geo. J. Mackay, technical officer; Alice E. Dear, stenographer and typist; Francis H. S. Knowles, physical anthropologist; Albert O. Hayes, junior geologist; Charles M. Sternberg, preparator, invertebrate palæontology; James Hill, junior geologist; M. G. Brown, assistant dry plate photographer. Most regrettable events affecting the Survey in connexion with the Canadian Arctic expedition were the deaths during the year of G. S. Malloch, geologist, and Henri Beauchat, anthropologist. Mr. Malloch had already done much valuable geological work and his sad death in the north cuts short a career of great promise. Mr. Beauchat's work is referred to in the report of the anthropologist on a later page.

GEOLOGICAL DIVISION

The work of the Geological Division, as in previous years, covered portions of the Dominion from Nova Scotia on the extreme east to the western islands of British Columbia and included explorations in Yukon and the Arctic regions of Canada.

Special attention was devoted to regions which promised to be of interest economically and detailed investigations of several producing areas were made with a view to helping in their economical development.

In addition to work bearing upon the metallic mineral resources, important investigations were carried on in mineral fuels and clay products, and a beginning was made in mapping and classifying deposits of material suitable for road making, a work which the widespread need in Canada for better roads made peculiarly pressing, and one which the Survey with its stores of accumulated data and staff of trained observers is well fitted to undertake.

In a tentative way work was begun on a soil survey of Canada with the object of classifying the soils and ascertaining their agricultural capabilities in different districts.

The work of the staff, dealt with in order of location from west to east, is briefly summarized below:—

O. E. LeRoy, as geologist in charge of field parties, visited most of the provinces of Canada during the summer, reviewing the work in progress.

D. D. Cairnes spent the summer in general exploratory work in the southwestern part of Yukon Territory. A large part of the area was little known either geologically or geographically and, since placer gold, gold ores, copper ores, and lignite were known to occur there, it was considered important that its mineral resources generally should be reported on. Mr. Cairnes made a number of traverses across the district and examined most of the creeks.

C. W. Drysdale devoted the greater part of the season to detailed examination of the Ymir mining camp, west of the Nelson and Fort Sheppard railway, British Columbia, with the object of compiling a sketch geological and topographical map of the region that will serve as an aid in the development of the district. Mr. Drysdale spent a few weeks also at Rossland at the beginning of the season and gave some attention to regions adjacent to the Ymir field.

Stewart J. Schofield began a detailed geological study of the Ainsworth mining camp on the east side of Kootenay lake, British Columbia. Good progress was made in the examination of the various properties and it is the intention to complete the work next season. Mr. Schofield also made a geological reconnaissance in West Kootenay for correlation purposes.

J. D. Mackenzie completed the detailed examination begun last year of a portion of Graham island, British Columbia, and made a general examination of the whole island paying particular attention to the coal-bearing beds and to the bitumen-bearing rocks. He also spent a few weeks in studying the structure and character of the coal-bearing beds in one of the Flathead River areas.

J. A. Allan spent about two months in geological investigations in Rocky mountains and Yoho parks and adjoining districts, for the purpose of correlating certain of the geological formations and to secure material for a guide book to Rocky Mountains park.

D. B. Dowling spent the greater part of the field season in the vicinity of Calgary in investigations in connexion with the occurrence of oil. A period of three weeks at the beginning of the season was devoted to correlation work on the Cretaceous of southern Alberta and the Missouri river.

J. S. Stewart was engaged in geological investigation in an area of the foothills lying west of the Porcupine hills in southwestern Alberta.

S. E. Slipper gave his attention during the summer to the geological mapping of a special map-area in the Sheep River district.

Charles Camsell made an exploration of the regions lying between Athabaska and Great Slave lakes. The trip was successfully made from Athabaska lake by a previously unknown canoe route to Great Slave lake. Though Mr. Camsell reports that the economic possibilities of the region from a mining standpoint are not of great promise, his exploration has added very materially to our information regarding the geology and geography of a little known district of northern Canada.

F. J. Alcock explored in detail the north shore of Athabaska lake with the object particularly of reporting on the mineral resources of the region and of examining the claims already staked on some of the Pre-Cambrian belts.

F. H. McLearn examined in detail the sections of Cretaceous rocks exposed along the Crowsnest river, Alberta, with the object of establishing their succession and the conditions under which they were laid down. The knowledge acquired will be most useful in structural work in the coal fields of southern Alberta. Mr. McLearn also examined a set of cores from deep wells in the vicinity of Winnipeg, with the object of determining the formations passed through.

Bruce Rose continued his work on the lignite areas of southern Saskatchewan and extended his examinations of last year westerly to the Wood Mountain areas. The lignites were found on analysis to be of good quality and very similar to those found in the eastern area. Mr. Rose also made a preliminary geological examination along the Red Deer, James, Clearwater, and North Saskatchewan rivers with the object of securing data that would aid in prospecting for oil in those districts.

E. L. Bruce examined a section of country lying to the north of Saskatchewan river in Saskatchewan. The exploration was particularly directed to a more detailed examination of the Pre-Cambrian belts that had been found to be gold-bearing in the neighbourhood of Amisk lake and farther west.

Alexander MacLean spent a week in geological work on the Gilbert plains, Manitoba, and the rest of the field season in the Pembina Mountain region near the International Boundary. Mr. MacLean kept in view the question of the possible occurrence of oil and gas and the adaptibility of the various shale beds for manufacturing purposes.

R. C. Wallace completed the field work for a memoir on the gypsum deposits and brines of Manitoba.

W. A. Johnston spent most of the season in the Lake Simcoe district where, in his geological mapping he included the delimitations of the different surface soils, and the sand and gravel deposits. In addition the examination of the surface geology of the valley of Rainy river begun last year, was completed.

W. H. Collins explored portions of the country adjoining the north shore of Lake Huron mainly with the object of connecting and correlating the geological knowledge already acquired in various economically important districts within the area.

M. Y. Williams continued the geological investigation of the Silurian system of southwestern Ontario, surveying the area between the Bruce peninsula and Niagara. These formations include the principal sources of salt, lime, gypsum, and cement Mr. Williams also gave attention to the location and mapping of deposits of gravel suitable for road making and to building stones and stone used for concrete.

Joseph Keele investigated the clay and shale deposits of southern Ontario, the principal workable deposits of shale being found on the shores of Lakes Ontario and Huron. The deposits of Pleistocene clays are widely spread over the province and vary very much in quality in different localities.

Leopold Reinecke spent the field season in Ontario in an investigation of the materials suitable for road making. Among these are various kinds of solid rocks that are broken for use, and unconsolidated gravels. The classification of these deposits into various grades particularly adapted to different types of road surfaces and their location and mapping should prove of very great value.

Stopford Brunton examined several districts in Ontario with a view to the location of radio-active minerals, making field tests with apparatus that was carried from place to place. Though the investigation for the most part had negative results, radio-activity was found in the minerals of some localities.

M. E. Wilson continued the geological work in Ottawa and Labelle counties, Quebec, begun last year, extending his explorations into the northwestern portion of the area and making detailed geological maps of some of the mica mines.

H. C. Cooke explored the Broadback river, Quebec, making a micrometer survey of the upper part of the river. Along the line of traverse the rocks were found to be chiefly granitic, only a few narrow belts occurring that give promise of carrying valuable minerals

T. L. Tanton made a geological reconnaissance of a region bordering the Harricanaw river in northern Quebec. The area forms part of the Pre-Cambrian complex of northern Canada, and certain belts were found that seem to warrant the attention of the prospector.

Robert Harvie continued the examination of a section across the Sutton Mountain anticline, in the Eastern Townships of Quebec. The information gained gives a key to the general geological structure in the Eastern Townships and will be of great value to the mining industry of that district.

A. Mailhiot spent the field season in a detailed examination of the Hereford, Big Megantic, and Scottstown granite areas of Quebec. In addition to the scientific results obtained, Mr. Mailhoit secured information regarding the occurrences of rocks and minerals of economic value.

Albert O. Hayes, in continuation of the work begun last year, made a detailed examination of certain typical areas near St. John, New Brunswick, and ran stadia transit traverses for mapping purposes. He also examined a number of limestone quarries in the district.

W. J. Wright made a detailed investigation of the gypsum and manganese deposits and petroleum-bearing formations in the vicinity of Moncton, New Brunswick. The areal mapping of the district was continued, and material for a geological map was secured.

J. W. Goldthwait, who spent the summer of 1913 in the study of the physiography and surface geology of Nova Scotia, completed the work during the past field season and will prepare a bulletin on the subject.

E. R. Faribault continued the geological and topographical mapping of Queens county, Nova Scotia, an area underlain almost entirely by the gold-bearing series. Mr. Faribault traced the courses of five anticlines and located the position along them of the principal domes, a structural feature that largely governs the occurrence of gold in economic quantity.

W. A. Bell spent the summer in detailed investigation of the Carboniferous rocks of an area in the neighbourhood of Windsor, Nova Scotia, a work of importance in the elucidation of structural problems connected with the occurrence of the higher productive coal beds farther east.

Jesse E. Hyde was engaged in structural geological work in Nova Scotia and Cape Breton, mainly in the region between St. Ann harbour and Sydney.

C. W. Robinson carried out a series of explorations for radio-active minerals in Nova Scotia, New Brunswick, Quebec, and eastern Ontario. He also collected specimens for the mineralogical division of the Museum.

J. J. O'Neil, who accompanied the Canadian Arctic Expedition as geologist, making his temporary headquarters at Herschell island about 155 miles east of the main winter quarters of the Expedition at Collinson point, Alaska, was able to examine geologically an interesting section of the Arctic coast line between Demarcation point and the mouth of Mackenzie river.

VERTEBRATE PALÆONTOLOGY.

L. M. Lambe, vertebrate palæontologist, studied and described a large amount of newly acquired material, chiefly from the Cretaceous of Alberta, and superintended the installation of many additions to the collection in the Hall of Vertebrates in the Museum.

Charles H. Sternberg, preparator and collector, assisted by his sons, C. M., G. F., and L. Sternberg, made a large collection of reptilian remains from the Belly River formation of Red Deer river, Alberta, and made good progress in the preparation for study and exhibition of much of the material collected in previous years.

STRATIGRAPHICAL PALÆONTOLOGY.

E. M. Kindle was engaged in field work in Ontario, Quebec, and Nova Scotia. Important geological sections were examined in these provinces, and an investigation of some of the problems of sedimentation was undertaken in the Bay of Fundy and Lake Ontario.

E. J. Whittaker assisted Mr. Kindle throughout the field season.

M. Y. Williams continued work on the Silurian stratigraphy and palæontology of the Ontario peninsula.

L. D. Burling made a short trip to southern Quebec in company with Mr. R. Harvie, but spent most of the summer in the office, working out the palæontological results of his trip of the preceding summer to the Alaskan boundary.

W. J. Wilson spent most of the year in examining the large mass of material already accumulated, studying particularly the collection from the Carboniferous rocks of New Brunswick. He also named and arranged the collections brought from the field during the previous season.

MINERALOGY.

R. A. A. Johnston completed during the year the manuscript for a "List of Canadian Minerals," which it is proposed to publish as a memoir. He arranged special collections of radium-bearing minerals which have been distributed for exhibition at various points throughout Canada from Halifax to Dawson, and reported on many specimens sent in for determination.

Eugene Poitevin was engaged throughout the year in mineralogical work. He spent part of the summer in collecting in the vicinity of the Black Lake mines, Quebec.

A. T. McKinnon devoted his time to the collection and preparation of materials for the educational collections of minerals.

BORING RECORDS.

E. D. Ingall continued his work of collecting records of boring operations throughout Canada, with a view to so classifying and correlating them that advice and aid may be given to drillers as to the location of future boreholes.

TOPOGRAPHICAL DIVISION.

W. E. Lawson mapped the Rainy Hollow district, B.C.

F S. Falconer mapped the Ainsworth map-area, British Columbia, and began the mapping of the Revelstoke sheet, British Columbia.

A. C. T. Sheppard completed the mapping of the Flathead and Crowsnest sheets, British Columbia and Alberta.

E. E. Freeland began the mapping of the Sheep River map-area, Alberta.

A. G. Haultain was engaged in making the survey of Lake Athabaska, Alberta and Saskatchewan.

D. A. Nichols completed the Thetford-Black Lake map-area, Quebec.

B. R. MacKay completed the New Glasgow map-area, Nova Scotia.

S. C. McLean was engaged in running traverse control in Queens county, Nova Scotia, and in completing the triangulation in the Similkameen and Osoyoos districts, British Columbia.

K. P. Chipman and J. R. Cox are still with the southern party of the Canadian Arctic expedition.

BIOLOGICAL DIVISION.

BOTANY.

John Macoun spent his whole time in the vicinity of Vancouver and Sidney, British Columbia, devoting his attention, particularly, to the collection and study of cryptogams.

J. M. Macoun gave most of his time to the routine work of the division but found time to nearly complete a work on the flora of the Ottawa district, and to make progress with several other papers. Mr. Macoun spent part of the summer on Vancouver island, on islands in the Gulf of Georgia, and on the Pribylov islands.

ZOOLOGY.

P. A. Taverner, accompanied by C. A. Young, spent part of the summer about the shores of Chaleur bay in northern New Brunswick and Quebec, studying the habits of the water birds of the region and collecting bird-skins. Mr. Taverner also devoted his attention to the arrangement in systematic order of the stored collections, and to the Museum exhibits in zoology. Clyde Patch devoted his time to preparatory work and to the arrangement of old Museum material in new, temporary groups for exhibition purposes.

R. M. Anderson, who accompanied the Canadian Arctic expedition as chief of the southern party, made a large collection of northern birds and mammals, part of which has already reached Ottawa.

ANTHROPOLOGICAL DIVISION.

ETHNOLOGY.

E. Sapir, in addition to supervision of anthropological work, completed, during January and February, a five months' ethnological trip among the Nootka Indians of the west coast of Vancouver island. An extensive series of Indian texts, chiefly dealing with mythology, was secured, also a large amount of data on social organization, religion, and other aspects of ethnology. Phonograph records of Indian songs and museum specimens were collected.

C. M. Barbeau spent two weeks among the Huron Indians of Lorette, Quebec, in obtaining a series of French Canadian tales current among these Indians, primarily with the object of determining what influence, if any, European folk-lore has exercised on native Huron mythology.

F. W. Waugh paid a brief visit to the Iroquois of Six Nations reserve, Ontario, to complete technological data obtained in previous trips.

J. A. Teit continued making ethnographical collections among the Interior Salish tribes of British Columbia, and secured a large and valuable series of photographs.

P. Radin continued his ethnological and linguistic work among the Ojibwa of Ontario and adjoining parts of the United States.

A. A. Goldenweiser continued his work on the social organization of the Iroquois Indians, devoting his time during this season primarily to the Tuscarora of New York state.

E. W. Hawkes undertook a general ethnological reconnaissance of the Eskimo of Labrador and Hudson bay, devoting special attention to the culture of the Labrador Eskimo. A large collection of Eskimo specimens was obtained.

W. D. Wallis undertook an intensive ethnological investigation of the Sioux Indians of Manitoba, special attention being devoted to ceremonial organization. An ethnological collection was obtained.

D. Jenness, of the Canadan Arctic expedition, carried on extensive archæological digging at Barter island, resulting in a large collection, and made progress on various aspects of Eskimo ethnology, an unusually extensive series of cat's cradle figures being secured.

ARCHÆOLOGY.

H. I. Smith, in addition to supervising archæological work, investigated one of the shell heaps at Merigomish in northern Nova Scotia. A collection of probably early Micmac objects was secured there.

W. J. Wintemberg made a general reconnaissance of Algonkian sites in the St. Lawrence valley south of Ottawa.

W. B. Nickerson continued on a more intensive scale work begun in previous years on the archæology of southwestern Manitoba. A more than usually satisfactory archæological collection was obtained.

MUSEUM.

In the Museum large additions have been made during the past year to the collections in all the divisions. Further large consignments have been received from the bone deposits in Red Deer, Alberta. The collections of invertebrate fossils have been largely augmented both with Canadian and foreign specimens. A fine suite of bird skins and eggs was collected on the coast of the Gulf of St. Lawrence. Important accessions have also come to the Division of Ethnology. A notable addition to the Museum collections is the Foote collection of meteorites, representing over two hundred "Falls." This division is still in need of exhibition cases for the display of specimens and of storage rooms for the care of collections. A number of steel storage cases received during the past year serve to alleviate, but do not by any means overcome the congestion. This condition of congestion, in fact, extends to all divisions of the Survey, the need for adequate storage room for publications and collections being especially pressing.

In pursuance of the policy of securing the assistance of specialists not on the office staff, the Geological Survey has been fortunate in the appointment of Dr. Gordon Hewitt, Dominion Entomologist, as Honorary Curator of Entomology.

GEOGRAPHICAL AND DRAUGHTING DIVISION.

The staff of this division is composed of the Geographer and Chief Draughtsman, his assistant map compilers and draughtsmen, and one clerk..

Besides 61 maps and a second collection of the Geological Congress special maps at present in the hands of the King's Printer and a large number of diagrams, sketches, and other illustrations, 47 new maps have been published during the year.

PHOTOGRAPHIC DIVISION.

The division did much valuable work during the year, particularly in connexion with the Draughting and Topographic Divisions and in the illustrations of reports. Summarized, the work consists of:—

Contact prints (vandyke, linen, black and white), size 4 × 5 to 36 × 48.	12,207
Bromide enlargements, size 4 × 5 to 40 × 72	793
Films and plates developed, size 3¼ × 4¼ to 6½ × 8½	4,220
Dry plate negatives made, size 4 × 5 to 11 × 14	522
Wet plate negatives made, size 8 × 10 to 16 × 20	89
Photostat copies, size 7 × 11 to 11 × 14	1,734
Lantern slides, size 3¼ × 4¼	236
Photos and titles mounted	1,238

GEOLOGICAL DIVISION.

EXPLORATION IN SOUTHWESTERN YUKON.

(D. D. Cairnes.)

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Introduction.

REASONS FOR WORK.

The summer of 1914 was spent by the writer in conducting general exploratory work throughout the southwestern portion of Yukon Territory north of the latitude of Whitehorse. The work was undertaken for the purpose of obtaining as much information as possible relative to this extensive region, concerning the greater part of which very little was known of a geological or even, in places, of a geographical nature.

Placer gold has been mined on a number of creeks in Kluane district since 1903, and has also been produced in small quantities from Nansen district since 1910, having been originally discovered there in 1899. Deposits of lignite were also known to occur in Kluane district, and placer gold, gold ores, copper ores, lignite, and other minerals were reported to have been found at a number of other points throughout this general region. Nevertheless, although this section of Yukon would thus seem to possess considerable promise of future economic importance, almost the only authentic information available concerning it was the result of the work of Mr. R. G. McConnell who spent the summers of 1903 and 1904 in Kluane district[1] and along certain headwaters of White river.[2] and even these investigated areas include only a very small portion of Southwestern Yukon. Moreover, since 1904 practically no information at all had been obtained concerning the entire region here under consideration, until 1913 when the writer devoted part of the summer to the examination of Upper White River district,[3] which, however, also occupies only a small section of the extreme western part of this wide, largely unexplored tract.

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[1] McConnell, R. G., "Headwaters of White river": Geol. Surv., Can., Sum. Rep. for 1905, pp. 19-26.

[2] McConnell, R. G., "The Kluane Mining district": Geol. Surv., Can., Sum. Rep. for 1904, pp. 1A-18A.

[3] Cairnes, D. D., "Upper White River district": Geol. Surv., Can., Sum. Rep. for 1913. "Upper White River district": Geol. Surv., Can., Memoir No. 50, 1914.

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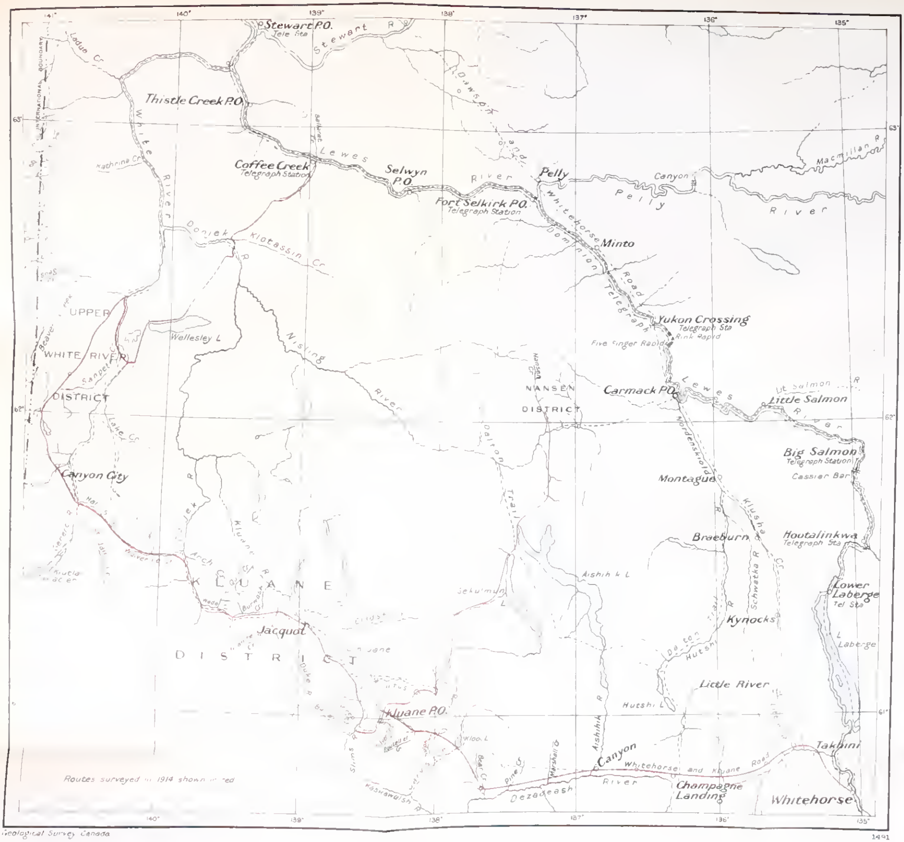

Geological Survey Canada

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Diagram of southwestern portion of Yukon Territory

Scale of Miles

10 5 0 10 20 30 40 50

To accompany Summary Report by D.D.Cairnes 1914

It seemed very desirable, therefore, and even urgent that as much economic and scientific data as possible should be obtained concerning this region, particularly since placer gold in economically important amounts had been discovered during the summer of 1913 in Chisana district,[1] Alaska, not more than 30 miles west of the Yukon-Alaska International Boundary line. As a result of the finding of gold in Chisana, a large number of prospectors, miners, and others had passed through or visited the adjoining portions of Yukon, and many of these prospectors had either remained in Yukon or had returned there, and were reported to have made important discoveries of valuable minerals in various localities. Accordingly the writer was instructed to spend the field season of 1914 in Southwestern Yukon, and to obtain as much general information as possible concerning this region, special attention to be given to the occurrences of economically important mineral deposits.

WORK PERFORMED.

The greater part of the summer was devoted to traversing, although some areal mapping was also performed. The different traverses were located so as to crosscut the major geological and physiographic features or terranes of Southwestern Yukon along a number of somewhat widely separated lines, and were so arranged as to connect with or pass through the leading mining areas. It was hoped to obtain in this way the greatest amount of valuable information concerning this region, in the shortest possible time.

Commencing at Whitehorse, a traverse was run along the wagon road to Kluane, a distance of 150 miles, and the geology was mapped along the route for a width of from 2 to 6 miles, the mapped portion being, however, in most places from 3 to 4 miles wide. Along this traverse, as in the case of all the other traverses this season, the width to which the geology was mapped on either side, was conditioned largely by the accessibility of rock outcrops.

From Kluane, a traverse was extended to Nansen creek, a distance of 103 miles. Trails were followed where they occurred, but for the greater part of this distance no trails, or at best, only poorly defined Indian trails were available. The geology was mapped along the line of travel for a width of from 3 to 6 miles, the mapped strip being in most places, however, about 4 miles wide. During this trip the gold-bearing gravels on Ruby creek and on Fourth-of-July creek and its tributaries, were examined. Also an area 10 miles long, by 7½ miles wide, including Nansen creek, was geologically mapped. This area is here designated Nansen district, and includes all the known gold-bearing creeks in that vicinity.

Returning again to Kluane, a traverse was made along the upper (south) end of Lake Kluane to near the north end of the lake, and was from there continued up Burwash creek, down Wade creek to Donjek river, down the Donjek and across this river to Wolverine creek, up Wolverine creek to its head, thence down Harris creek to Generc river, across the river, and from there to Canyon City, a distance from Kluane of 132 miles. A blazed trail was followed the greater part of this distance. Between Kluane and Canyon City, the placer gold gravels of Bullion, Sheep, Burwash, and Arch creeks were examined; the lignite deposits at the head of Sheep creek and between the upper portions of Burwash creek and a tributary of Duke river were investigated; and the copper deposits along Quill creek, and between this stream and Burwash creek were visited.

After arriving in Canyon City, which is situated near the southern end of Upper White River district, camp was moved to near the mouth of Pan creek. The gold-bearing gravels on this stream and on adjoining creeks were then examined, and afterwards about a week was devoted to completing the geological mapping in the northern portion of Upper White River district. A number of hills or mountains within this district were not examined the previous summer (1913) owing to lack of time, as the writer had to leave the field early in August to act as guide on certain of the excursions of the International Geological Congress.

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[1] Cairnes, D. D., "The Chisana Gold Fields": Jour. Can. Min. Inst., vol. xvii, 1914, pp. 33-61.

Having completed the geological mapping of Upper White River district, a traverse was commenced at the mouth of Sanpete creek, and extended to the mouth of Coffee creek on Yukon river, a distance of 91 miles. Throughout this distance, the geology was mapped for a width of from 2 to 4 miles, the mapped strip, in most places, being, however, about 3 miles wide.

Altogether about 476 miles were traversed, and as the geology was mapped along the routes travelled for an average width of about 4 miles, approximately 1900 square miles were geologically mapped along these traverse lines; in addition, the topography was also approximately sketched along both sides of the travelled routes. Also, Nansen district with an area of over 75 square miles, as well as portions of the northern part of Upper White River district, were mapped, making a total of about 2,100 square miles of geological mapping. Further, the gold-bearing gravels, copper deposits, lignite seams, and other occurrences of economically important minerals were examined throughout Kluane and Nansen districts, as well as in portions of Upper White River district.

In traversing, the distances were estimated by means of an odometer or measuring wheel. The routes were plotted, and the topography on either side of the traverse lines was sketched on a plane-table sketch board. Sun azimuths were taken morning and afternoon to correct the magnetic readings of the compass needle on the sketch board. The work was plotted in the field on a scale of $\frac{1}{192000}$ or about 3 miles to the inch. In Nansen district, the base lines on the various creeks, run by H. G. Dickson, D.L.S., of Whitehorse, Yukon, were used as a base, and these traverses were extended, where it was found necessary, to complete a drainage map of the area, on which to plot the geology.

ACKNOWLEDGMENTS.

The writer was assisted in his work in every way possible by all the prospectors, miners, and others with whom he came in contact, a cordial co-operation being everywhere extended, for which he wishes to express his sincere gratitude. Particular thanks are due to Mr. A. D. MacLennan, Mining Recorder of Kluane mining district, who supplied a great amount of valuable information from his office, and accompanied the writer's party as far as Fourth-of-July and Ruby creeks, to facilitate the work of investigation in the portions of Kluane district with which he was most familiar.

The writer's assistants for the season were F. J. Barlow, Robert Bartlett, and E. C. Annes. Mr. Barlow assisted with the geological work, while the Messrs Bartlett and Annes devoted their time to the topography. All performed the duties assigned them in a perfectly satisfactory and highly efficient manner.

EXTENT OF REPORT.

In this summary report the more salient features of economic interest will be described and the general geology of certain areas or localities will be briefly outlined, where such an outline is necessary to a clear understanding of the importance of the mineral deposits. It is the intention of the department later to publish a memoir in which the writer will give all the information available concerning the southwestern portion of Yukon, including detailed descriptions of the geology, mineral, and other natural resources.

Mineral Resources.

GENERAL STATEMENT.

The mineral resources of the portion of Southwestern Yukon here under consideration include mainly, so far as is known at present, placer gold, copper deposits, and coal. Quartz veins containing gold, silver, and, in places, copper, occur in certain localities, but no veins have yet been discovered containing these minerals in sufficient quantities to be of present economic value.

Of these resources, placer gold is of the most immediate economic importance, leaving out of consideration the copper deposits of the Whitehorse belt which were not examined by the writer during the past summer, but which are included in the region represented by the accompanying map. In addition to the occurrences in the Whitehorse belt, deposits carrying copper minerals have been found in a number of other localities within this portion of Southwestern Yukon, but none have so far been discovered that could be exploited under existing conditions. Extensive deposits of coal (lignite) occur in Kluane district and vicinity, and constitute a valuable future asset, but at present there is only a very small local consumption, and owing to its inaccessibility, it is not at present shipped to other points.

PLACER GOLD.

Distribution.

Placer gold has, up to the present, been found mainly in Kluane and Nansen districts, though promising discoveries have been made on two or three creeks in Upper White River district; and at a number of isolated, widely separated points, other finds have been made, some of which may prove to be of economic value.

On Koidern river [1] which joins White river on the right bank [2] about 18 miles below the mouth of Generc river, important discoveries of gold-bearing gravels are reported to have been made. On Albert creek, which empties into the northern end of Lake Sekulmun, a number of claims have been located, and both Indians and white men stated to the writer, that they had found very encouraging prospects on this stream. A number of men have recently been engaged in prospecting on Klotassin creek, an important tributary of Donjek river, and on certain of its branches, and in some cases, report quite satisfactory results. On several of the upper tributaries of Nisling river, in addition to the creeks included in Nansen district, prospecting has been carried on during the past two years with encouraging results. On Coffee creek prospecting work was performed during the winter of 1913-14, but it is believed that no deposits of gravels that would pay to work were found.

So far as the writer's information goes, only in Kluane and Nansen districts, are gravels known to have been found as yet that can be profitably exploited. Throughout a large portion of this extensive region, nevertheless, the geological conditions are particularly favourable for the accumulation of valuable deposits of gold-bearing gravels, the bedrock formation over wide areas, consisting dominantly of the older schists similar to those so extensively developed in Klondike and Sixtymile districts. Further, the northeastern part of the region lies entirely outside of the glaciated zone. This feature of non-glaciation is important since it means that wherever gold has been concentrated in the stream gravels, it probably remains undisturbed, and that the gold-bearing gravels are not overlain by vast accumulations of glacial detritus as they are farther to the west and south. In the Klondike, these two conditions appear to be mainly accountable for the richness of the stream gravels; in the first place, the bedrock consists dominantly of the old, highly mineralized schists which originally carried the gold; and in the second place the district has not been glaciated.

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[1] Also known as Lake creek.

[2] In Yukon, the terms right limit and left limit are commonly used to designate the right bank or left bank of a stream, meaning the right or left side, respectively, as observed by a person facing downstream.

In spite of the fact, however, that Southwestern Yukon would thus seem to be geologically so favourable for the occurrence of placer gold, as well as other minerals, very little prospecting has been done except in a few scattered localities, and the mineral resources remain almost entirely unexplored. It is quite possible or even probable, therefore, that important finds of placer gold will yet be found in this general section of Yukon Territory, and it would be well in prospecting, that particular attention should be given to the northeastern unglaciated portion of the district.

Kluane District.

General Description.—Kluane district is situated in the western portion of Southwestern Yukon, and lies along the northeastern slopes of the St. Elias range of mountains, between latitudes 60° 50′ and 61° 40′. It is so named because it includes Kluane lake, a body of water over 35 miles in length, which lies near the centre of the district.

Attention was first directed to Kluane district as a mining area during the summer of 1903, when placer gold was found to occur at a number of points. Discovery claim on Fourth-of-July creek was staked on July 4, of that year, by Dawson Charlie, a well-known Indian of Carcross. During the remainder of 1903 and the summer of 1904, a great number of placer claims were located, the majority of the creeks throughout the district being staked; and from that time to the present, the district has continued to produce placer gold. The output, however, has always been small, and the number of men engaged in placer mining since 1904, has decreased yearly.

The present status of the placer mining industry in Kluane mining district, is summarized in the report of Mr. A D. MacLennan, Mining Recorder, who writes of it in his annual report for the year ending April 30, 1914, as follows:—

"Seventy-one renewal grants and twenty-five relocation grants were issued during the year. Actual mining reached its lowest ebb during the past year. The season was unfavourable for much successful mining.

"On Burwash, Sheep, and Bullion creeks, the unusually high water caused considerable damage to mining outfits, and by the time this damage was repaired and work resumed, the stampede to the new placer camp in Chisana, Alaska, attracted the miners of Kluane district. The stampede to Chisana, however, brought a number of miners and prospectors through Kluane district, and of these a number remained, and are now prospecting on different creeks of the district."

Thus, throughout the entire Kluane mining district, only 96 placer claims were held on April 30, 1914, and very few locations were made during the summer.

For a description of the Kluane mining district, including an account of the mineral resources, the general geology, the original discoveries, and of the developments until and including 1904, the reader is referred to Mr. McConnell's report on the district.[1]

Geologically, Kluane district is divisible into a northeastern and a southwestern part, lying on opposite sides of Kluane lake, and nearly equal in areal extent. The northeastern division is situated within the Yukon plateau physiographic province, and is underlain dominantly by mica and quartz-mica schists which range in character from finely-textured and highly schistose rocks, to coarsely textured members having in places a decided gneissoid appearance. These schists belong to the Yukon group[2] which includes the oldest rocks known to occur in Yukon or Alaska, and are thought to be of Pre-Cambrian age. This group of rocks as developed in Kluane district has been locally named by Mr. McConnell, the Kluane Schists.[1] These schists have been invaded by granitic intrusives which are extensively developed in places, and are believed to be of Jurassic or Cretaceous age.

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[1] McConnell, R. G., "The Kluane Mining district": Geol. Surv. of Can., Sum. Rep. for 1904, pp. 1A-18A.

[2] Cairnes, D. D., "Geological section along the Yukon-Alaska Boundary line between Yukon and Porcupine rivers": Bull. Geol. Soc. Amer., vol. 25, 1914, pp. 181-187.

Cairnes, D. D., "The Yukon-Alaska International Boundary between Porcupine and Yukon rivers": Geol. Surv., Can., Memoir No. 67, 1914, pp. 38-44.

The southwestern portion of Kluane district lies along the inner or landward edge of the St. Elias range, and includes rocks ranging in age from probably Pre-Cambrian to Tertiary. Of the rocks exposed between Bullion creek and the lower (northern) end of Kluane lake, certain of those outcropping along Bullion creek are believed to be the oldest. They include mainly phyllites, cherts, and limestones, and are thought to belong to the Tindir group[2] which is probably of Pre-Cambrian age. Overlying these rocks are several hundred feet of calcareous, argillaceous, and arenaceous sediments which are known to range in age from Silurian to Triassic, and may include pre-Silurian members and post-Triassic Mesozoic beds. These sediments have been extensively invaded in places by granitic intrusives, and have also been pierced and overlain by a group of basic to semi-basic igneous rocks, including mainly andesites, diorites, diabases, and basalts. These igneous members appear to be mainly of Jurassic or Cretaceous age, but some may be as old as Carboniferous. All these older rocks are overlain in places by a thick series of Tertiary lignite-bearing beds which locally contain intercalated tuffs. The rocks of this Tertiary series are in turn invaded and overlain by basic to semi-basic lavas and associated pyroclastics, which are mainly of Tertiary age, but may include some Pleistocene members.

The entire Kluane district has been extensively glaciated, and the valleys are floored almost everywhere with boulder clay, gravels, silts, and morainal accumulations, which are in places several hundred feet in thickness.

The creeks of Kluane district fall naturally into two groups: those of the northeastern and those of the southwestern portions of the district. The southwestern creeks head in the St. Elias range and drain by Kluane, Donjek, and Yukon rivers into Bering sea. The northeastern streams traverse the western or southwestern edge of the Yukon plateau and most of them head in the Ruby range; they drain either into Kluane lake and thence to Bering sea, or join the headwaters of Alsek river flowing to the Pacific ocean. The creeks of each group possess geologically many common characteristics but the members of each group differ in a number of fundamental respects, from the members of the other group.

The principal gold-bearing creeks of the northeastern group include Fourth-of-July creek with its tributaries, Ruby creek, and Gladstone creek. Fourth-of-July creek, Ruby creek, and the lower gold-bearing portion of Gladstone creek, flow in depressions cut through the old Kluane Schists. The valley bottoms, except near the heads of the streams, are deeply floored in most places with glacial accumulations, mainly with boulder clay, through which the present streams are entrenching their channels. The pre-Glacial channels are thus in most places buried under glacial deposits and lie below the levels of the present streams. The gold that has been obtained, therefore, has been mainly derived from the recent gravels which overlie the boulder clay, the "clay bedrock" of the miners, the buried pre-Glacial channels having nowhere as yet been found. On the upper portion of Ruby creek, however, some gold has been derived from the gravels of the present stream where they lie on the schist bedrock.

The most important gold producing streams in the southwestern portion of the district are Bullion creek, Sheep creek, and Burwash creek with its tributary Tetamagouche creek. Some gold has also been obtained from Arch creek, a tributary of Donjek river, but as this stream is isolated from the other gold-bearing creeks of the district, it will be described separately.

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[1] McConnell, R. G., Op. cit., pp. 4A-6A

[2] Cairnes, D. D., "Geological section along the Yukon-Alaska Boundary line between Yukon and Porcupine rivers": Bull. Geol. Soc. Amer., vol. 25, 1914, pp. 157-190.

Cairnes, D. D., "The Yukon-Alaska International Boundary between Porcupine and Yukon rivers": Geol. Surv., Can., Memoir No. 67, 1914, pp. 41-58.

The bedrock of Bullion, Sheep, and Burwash creeks, ranges in age from Pre-Cambrian (?) or lower Palæozoic to Tertiary, both sedimentary and igneous members occurring. The old channels on these streams have been deeply buried under accumulations of boulder clay and other glacial detritus, but the present streams, particularly in the lower portions of their valleys, have lowered their channels through the glacial accumulations, and have eroded deep canyon-like channels in the underlying bedrock. Thus, except along the uppermost portions of these streams, the old pre-Glacial channels have either been destroyed by the present streams or lie to one side of them and at various elevations above them. This is in decided contrast to the streams in the north-eastern portion of the district, where all the old channels in the lower portions of the creek valleys are below the levels of the present streams.

Placer mining operations in the southwestern portion of Kluane district, have so far been almost entirely confined to the recent gravels that have accumulated on the bedrock formations of the different creeks. The positions of the old channels are in places quite evident, and sections of them are at certain points plainly in view along the valley sides; but owing to the great expense and time involved for their exploration, these channels remain as yet practically unexplored.

Throughout Kluane district, the bulk of the placer gold was originally concentrated in the old pre-Glacial channels which are now in most places deeply buried, and a great part of it may be still there. However, to determine the position of these old channels and to prospect them, means a large outlay of time and capital, and there is no certainty that at any particular point the old gravels have not been swept away by the ice, and their gold contents scattered.

Coarse gold has also been found on a number of other streams, but not, apparently, in sufficient quantities to pay for working. On Cultus creek some prospecting has recently been done, and on an unnamed tributary joining that stream on its left bank, gold is reported to have been found in encouraging amounts. Prospects have also been found on Printers (New Zealand), McKinley, and Dixie creeks, and some work has been done on them, in places with fairly encouraging results. It has been reported also that gold has recently been discovered on some of the upper tributaries of Kluane river.

Ruby Creek.[1]—Ruby creek heads in the summit of Ruby range, and flows southwestward into Jarvis river after a course of 8 or 9 miles. It is a steep mountain stream with a large volume of water in spring and early summer. As the snows in the upper regions disappear, however, the amount of water gradually dwindles and in late summer is reduced to about 200 miner's inches. From its head to the point where it joins the valley of Jarvis river, Ruby creek occupies a narrow, deep, steep-walled depression from 3,000 to 4,000 feet in depth, cut down through the old Kluane Schists. The valley is deeply floored with boulder clay nearly to its head; and in the vicinity of Jarvis river the clay is overlain by extensive deposits of glacial silts. From about claim No. 21 above Discovery claim, to its head, Ruby creek has sunk its channel through the boulder clay, and has eroded a rock canyon with abrupt walls 10 to 30 feet in height in the underlying schists. In places along this upper portion of the stream's course, the grade is so steep—occasionally exceeding 400 feet to the mile—that even the recent gravels have been washed away and the bedrock exposed. Below claim No. 21, the stream with its gravels overlies the boulder clay, and although several shafts have been sunk along this portion of the creek, none have succeeded in reaching bedrock. Upstream from No. 21 above Discovery, bedrock is seldom more than 10 feet below the creek bed, although in places it is as much as 15 feet; below No. 21 it drops away suddenly and on No. 15 above Discovery, a shaft 68 feet deep failed to get through the boulder clay. It would seem quite possible therefore that the old pre-Glacial channel crosses the present channel just below No. 21 above Discovery, and that above this point it lies to one side of the present channel.

Mining operations have been confined to the portion of the creek above No. 20 above Discovery, and the gold that has been taken from Ruby creek has practically all been obtained between the mouth of Little Ruby and No. 20 above Discovery, a distance of about three-quarters of a mile, the gold being very unevenly distributed throughout the stream gravels. The wash along this portion of the creek represents, to a considerable extent, a residue or concentrate from the boulder clay, and consists mainly of flat pebbles and angular slabs of schist, with occasional large granite boulders, and a few quartz pebbles and boulders.

The total gold production of Ruby creek is probably between $6,000 and $8,000. The gold is coarse, rough, and occasionally crystalline, and has been derived from the underlying Kluane schists and their contained quartz veins.

Unless the old channel is found and proved to contain rich gold-bearing gravels, not much more gold is to be expected from this creek, as the body of recent gravels is small and has not proved to be high grade. The old channel might be prospected for either by drifting in on bedrock above No. 21 above Discovery, or by sinking below No. 21, and drifting along on bedrock. Two drifts have already been driven in on the right bank of Ruby creek above No. 21 above Discovery. They follow the nearly flat surface of the bedrock, in a direction about at right angles to the general course of the stream. These drifts were caved in when seen by the writer; but it was stated by Mr. MacLennan that each is over 100 feet long, and that the surface of the bedrock is smooth and level, as might be expected in the case of the bottom of a depression planated by ice. Although there is no certainty of finding gold anywhere under the boulder clay, as the stream gravels of the old channels may have been swept away during the glacial period, the chances of important discoveries on Ruby creek are favourable, and would seem to warrant a trial. There is little or no chance of finding gold in paying quantities along the creek, below the point where it enters the valley of Jarvis river, as there the gravels of the pre-Glacial channel have undoubtedly been scattered by ice which formerly moved through the Jarvis River valley.

Fourth-of-July Creek and Tributaries[1]—Fourth-of-July creek is also a tributary of Jarvis river, but is a much larger stream than Ruby creek, its flowage in early summer amounting to several thousand miner's inches; it also differs from Ruby creek in dividing up into several branches after entering the mountains. The creek has also cut a wide, deep valley back into the Ruby range, and its various branches including Snyder, Alie, and Twelfth-of-July creeks also occupy steep-walled depressions, incised deep in the southern slope of the mountains. All these depressions are typically U-shaped, and their walls are planated and smoothed from the effects of intense valley glaciation which extends practically to the summits on either side. Both the creek and its tributaries, throughout almost their entire courses, cut the Kluane schists. In places, however, greenstones and granitic intrusives are encountered, and on Larose creek the granitic rocks are quite extensively developed.

The valley of the Fourth-of-July creek is floored with boulder clay to above the mouth of Snyder creek, and near the edge of the valley of Jarvis river the boulder clay is in turn overlain by considerable thicknesses of glacial silts—some sands and gravels being also included. From a point a short distance above the mouth of Snyder creek, upstream to near its head, the boulder clay has been largely removed and the schistose bedrock is exposed. The present stream with its recent gravels, overlies the boulder clay from about three-quarters of a mile above the mouth of Snyder creek to the canyon which occurs near the edge of Jarvis River valley. On both sides of the stream between these points, the valley is deeply floored with boulder clay. At a few points, however, small schist outcrops occur along the sides of the creek and only a few feet above the water.

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[1] McConnell, R. G., Op. cit., p. 12A.

A number of claims are still held on Fourth-of-July creek, but during the past summer (1914) little work was done other than representation work to hold the ground. Shafts have been sunk in the valley deposits at various times, with a view to reaching bedrock, one of these shafts being approximately 70 feet in depth, but the bottom of the boulder clay and associated deposits was nowhere reached. In most cases the shafts are believed to have been abandoned owing to the amount of water encountered. Even in winter the ground along the creek is not deeply frozen—in most places to a depth of only about 5 to 10 feet, but at some points for as much as 20 feet—making sinking very difficult. Where the ground is frozen as in the Klondike, no water is encountered in sinking, and no timbering is required. With the exception of shafts sunk in the hope of finding the old creek channel, mining operations on the creek have been confined to the recent stream gravels which overlie the boulder-clay—"clay bedrock." These recent gravels with their gold content, really represent mostly a residual product or concentrate from the boulder clay, moved by the stream. They are in most places less than 10 feet in thickness, but at certain points the boulder clay extends nearly 20 feet below the stream bed. The gravels are similar to those on Ruby creek, and consist mainly of coarse angular and sub-angular fragments of schist associated with which are pebbles and boulders of quartz and some of granitic rock. Great boulders of the granitic rock 10 feet in diameter were seen in places.

Nearly all the gold that has been taken from Fourth-of-July creek was found between claims Nos. 65 to 77 above Discovery claim, the total amount being probably between $6,000 and $10,000. During the past summer, however, a small patch of fairly rich gravel was found on Twelfth-of-July creek near the mouth of Larose creek, from which several ounces of coarse gold was obtained in a few days, and other small amounts of gold have been found at a few outlying points.

The bulk of the gold in the valley as well as in the tributary depressions was undoubtedly originally concentrated in the old, pre-Glacial channels. The valley of Fourth-of-July creek is so wide, however, and its bedrock floor is so deeply buried under glacial accumulations, that there is very little surface evidence as to the position of the old channel. Near the edge of the Jarvis River valley, the creek flows through a short canyon with schist walls rising nearly vertically to a height of 50 feet in places. This canyon represents a recent stream channel, the old channel being buried under the glacial deposits flanking it.

To prospect for the old channel it would be necessary to sink to bedrock and drift. This would probably prove to be very expensive, and there is no certainty that at any particular point the gravels of the old channel with their gold contents were not swept away by the ice during the glacial period. Whether or not the old channel is found, however, there is still in places sufficient gold in the gravels of the present stream to yield wages or better, but it is very unevenly distributed.

Gladstone Creek.—Gladstone is one of the larger creeks of the district and trends in a general way almost due west, entering Kluane lake on its eastern side near the northern end. Its valley, like those of all the other creeks on the eastern side of the lake, is deeply floored with boulder clay and other glacial deposits. The rocks exposed along the lower 5 or 6 miles of the valley are dominantly the Kluane Schists. Above this, however, the granitic intrusives are almost continuously exposed along the valley walls.

A number of claims are held on this creek, but practically the only gold known to have been recovered was obtained by Messrs T. T. Murray and A. Swanson who hold Discovery claim and No. 1 below Discovery, Discovery claim being located just below the mouth of Cyr creek and about 2 miles from the mouth of Gladstone. These owners have worked their claims intermittently during the past few years, by the open-cut method, having worked to a depth of possibly 11 or 12 feet. Their mining operations have been entirely confined to the gravels of the present stream, which overlie the boulder clay, bedrock having been nowhere reached. They have obtained altogether possibly $2,000 or $3,000, the gold being really a concentrate from the boulder clay, which has been transported by the present stream.

A company of Whitehorse mining men worked this creek during the summer of 1913 with an Empire drill, owned by the Yukon government. They tried to locate the original pre-Glacial channel underneath the glacial deposits, but were apparently unsuccessful.

Bullion Creek.[1]—"Bullion creek is a typical St. Elias stream. It heads in small glaciers at the summit of the range separating Slims river and Kluane lake from Duke river, and empties into Slims river after a course of about 12 miles. It is a large swift-flowing stream, very variable in its flow, but carrying under ordinary conditions about 2,000 miner's inches of water. Its grade is steep, averaging over 200 feet to the mile, and in flood it assumes a torrential character."[2] The valley of the creek is a deep, steep-walled gorge 2,000 to 3,000 feet or more in depth, which, though narrow throughout, widens somewhat toward its lower end, i.e., as the edge of the Slims River valley is approached. During the Glacial period, Bullion Creek valley was almost completely filled with boulder clay and associated glacial deposits. After the retreat of the ice, the stream began actively re-excavating its old channel, and from a short distance above No. 20 above Discovery to the lower end of the valley, has not only succeeded in sinking its way through these glacial deposits, but has also cut some distance into the underlying bedrock. Thus from about No. 20 above Discovery to the edge of the Slims River valley, a distance of about 5 miles, the present stream flows through a steep-sided gorge with rock walls rising to heights in most places of from 50 to 200 feet. In the vicinity of Metalline creek which joins Bullion near the upper end of this 5-mile rocky gorge, Bullion creek for about one-fourth of a mile, forces its way through a canyon so narrow that at a short distance it looks like a mere cleft in the rock. This remarkable natural feature is due to a change in the course of the stream at the close of the Glacial period. After the retreat of the ice, the creek was crowded to the north by the wash brought down from Metalline creek and, instead of having only to clear out its old channel as along most other portions of its course, the stream had to sink a new channel in the bedrock; and as the downward cutting was very rapid, the incision is narrow. The former channel is plainly in view where it is cut by Metalline creek, about 200 feet above and on the south side of the bed of the present Bullion creek.

Along the greater part of its course from a point a short distance above No. 20 above Discovery, to its head, Bullion creek has not yet reached bedrock, and the creek gravels overlie boulder clay, the channel walls being also composed of detrital glacial deposits. These glacial accumulations continue to the mouth of the valley, bordering the rock-walled channel of the lower portion of the stream on both sides. They extend also in most places well up the valley walls, reaching to near the elevations of the bordering summits. These deposits, particularly the boulder clay, have weathered into a great variety of craggy and castellated forms, and constitute a very striking feature of this picturesque valley.

The rocks exposed in the valley of Bullion creek, include both sedimentary and igneous members which range from probably Pre-Cambrian to Tertiary in age. The dominant types are phyllites and limestones, although shales, cherts, greenstones, and rhyolitic intrusives are all somewhat extensively developed. The phyllites are prevailingly greenish, greyish, or yellowish in colour, and cleave readily into thin plates having bright, glistening surfaces from the abundance of mica contained in them. The limestones are nearly everywhere altered to marble, and are mainly white, yellowish, or black in colour. The shales and cherts are mainly dark-grey to black in colour and thinly bedded, although some massive cherts also occur. The phyllites and associated limestones, shales, and cherts, particularly along the lower portion of the valley, closely resemble the members of the Pre-Cambrian Tindir group [1] and probably belong to that geological formation. They underlie limestone beds in which on Sheep creek, a mile or so to the north, Silurian fossils were found. These beds have all been invaded by greenstones with which they are intimately associated. Certain limestone and shale beds farther up the creek as well as higher up the valley sides, are probably much more recent in age; Mr. McConnell collected fragments of corals from these beds, which are reported to "indicate a Carboniferous age." [2] All these older rocks are cut in places by dykes of a nearly white to yellowish rhyolitic rock which is thought to correspond to a similar intrusive of Tertiary age which occurs in numerous localities in Yukon. The rock section along the valley is highly and brightly coloured, and shows a great variety of shades and tints, adding much to the grandeur and scenic beauty of the valley.

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[1] McConnell, R. G., Op. cit., pp. 13A-15A.

[2] Idem, p. 13A.

Bullion Creek channel is floored in most places, except in the short canyon in the vicinity of the mouth of Metalline creek, with a layer of loose, recent gravels from 6 to 10 feet in thickness. Near the mouth of the valley, however, the depth to bedrock becomes somewhat greater. These gravels have been worked in places from near the mouth of the valley to about No. 40 above Discovery, but from all the information available, it would appear probable that not more than about $5,000 in gold has been obtained from the entire creek. At the beginning of last season (1914) no claims were held on the creek, but during the summer several locations or re-locations were made, and a few men, generally less than 10, spent a great part of the summer prospecting the gravels of this stream.

On Discovery claim, about 40 ounces of gold were obtained in a few hours in 1903, but in all only about $1,000 is believed to have been mined from this ground. On a number of other claims, including Nos. 14, 30, and 44 below Discovery, small amounts of gold have been obtained. In many places, up to No. 40 above Discovery, an average of $3 to $4 per day per shovel is obtainable, bedrock being reached to about No. 40 above Discovery. In only a few places, however, has gold been found in sufficient quantity to pay wages to miners for more than a few days at a time, the gold being nearly everywhere, apparently, very unevenly distributed.

The Bullion Hydraulic Company, under the direction of Mr. W. L. Breeze, operated along the lower portion of the creek during 1904, 1905, and 1906, and spent, possibly, $300,000, mainly in buildings, equipment, and various initial outlays. Only a small amount of actual placer mining was done, which is believed to have yielded about $1,000 in gold.

It is quite possible that gold in paying quantities may occur in the gravels of the old channel where it occurs along the benches, but these gravels are not known to have been prospected.

The gold on Bullion creek, in common with the other streams in the northwestern portion of Kluane district, is worn much smoother than that from the streams to the east of Kluane lake. It occurs on Bullion creek mainly in flattened pellets, occasionally of considerable size, nuggets up to an ounce in weight having been found. Some fine gold also occurs. The grade of the gold is high, averaging about $18 per ounce.

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[1] Cairnes, D. D., "Geological section along the Yukon-Alaska Boundary line between Yukon and Porcupine rivers"; Bull. Geol. Soc. Amer., vol. 25, 1914, pp. 187-190.

Cairnes, D. D., "The Yukon-Alaska International Boundary between Porcupine and Yukon rivers": Geol. Surv., Can., Memoir No. 67, 1914, pp. 44-58

[2] McConnell, R. G., op. cit., p. 6A.

Sheep Creek.[1]—Sheep creek resembles Bullion creek in many respects, but is a much smaller stream. It heads with Congdon creek, and after a course of about 8 miles debouches on the flats of Slims river, about a mile below the mouth of Bullion Creek valley—Sheep and Bullion creeks being in general nearly parallel. Sheep creek throughout the lower 3 or 4 miles of its valley, is a very swift stream, the average grade exceeding 300 feet to the mile; but above the mouth of Fisher creek it has a much more gentle gradient.

The valley of the creek, in common with that of the other smaller streams draining the landward slope of the St. Elias range, is deep, steep-walled, and gorge-like in character. During the Glacial period this depression became filled to a depth of 1,000 feet or more with boulder clay and other glacial accumulations. After the retreat of the ice, the stream immediately commenced re-excavating its channel, and from about the mouth of 74 pup to the lower end of its valley, a distance of between 3 and 4 miles, the creek has cut down into the underlying bedrock. Along this portion of its present course, Sheep creek flows through a narrow canyon with nearly perpendicular rock walls rising to heights in most places of from 100 to 200 feet. Above and below the canyon, the main valley walls rise abruptly 2,000 feet or more to the lofty bordering mountain summits. Throughout this lower portion of its valley, however, the stream in places became superimposed over bedrock to one side or the other of its former channel, and at such points, has been forced to cut downward very rapidly, to maintain grade, and the resulting incisions in such places are very narrow and cleft-like in character. Below Fisher creek, at least, the portions of this old channel which were not again occupied by Sheep creek, and thus still remain undestroyed, lie for the greater part on the left (northeast) side of the present stream. Commencing at about the mouth of 74 pup, and extending upstream, the valley of Sheep creek, particularly near the stream itself, is much less rugged and rocky in appearance, as throughout this upper portion of the creek's course, the stream in most places still overlies the boulder clay, not having as yet been able to sink its bed through the accumulations of this material. This boulder clay, with the other glacial debris, border the creek channel and extend well up on the valley sides. The stream here has a moderately gentle grade, and flows in a somewhat open valley which is strikingly in contrast with the rock canyon below, through which the water rushes and leaps over a succession of falls to the point where it joins the valley of Slims river.

The rocks exposed along Sheep creek are extremely varied in age and character. Along the lower portion of its course, limestones and greenstones predominate, and near the edge of Slims River valley, some cherts also occur intimately associated with certain of the limestone beds. The oldest rocks exposed include a group of marbles, cherts, and shales. The marbles are irregularly streaked or striped in appearance—nearly white and black streaks alternating. The cherts are prevailingly dark in colour, although white or greyish members occur, and nearly all are stained reddish with iron oxide. These older beds are overlain by more massive limestones which contain Silurian fossils. On the mountains to the north, Carboniferous limestones, shales, argillites, and associated beds also occur. All these beds are in places considerably distorted, folded, and broken, and brecciated zones are locally prominent. They have been invaded by greenstones which are extremely varied in character, and include diorites, diabases, andesites, and basalts. Along the upper portion of Sheep creek, Tertiary lignite-bearing beds are somewhat extensively developed. These include mainly conglomerates, sandstones, shales, clays, and associated tuff beds.

Mining on Sheep creek has been practically all confined to the comparatively shallow gravels of the present stream channel between claims Nos. 52 to 75 above Discovery. In all about $10,000 in gold is thought to have been obtained from the stream. The richest ground found was on No. 74 and the lower part of No. 75, from which Fisher brothers obtained $7,000 in about 40 days. The richness of this ground is apparently due to the fact that it lies just below a pup coming in from the left, which a short distance above its mouth apparently crosses the old stream channel.

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[1] McConnell, R. G., op. cit., p. 15A.

The distribution of the gold in the gravels of the present stream is very irregular and, in most places, the amount of gold is small. Undoubtedly other points remain, however, like Nos. 74 and 75 above Discovery, that occur below the mouths of tributaries cutting the old channel on the benches, which will pay to work. It would also seem highly advisable to prospect the old channel which, where still intact from a short distance above No. 74 pup to the mouth of the valley, lies on the benches, but from a short distance above 74 pup, is below the level of the present stream. The bulk of the gold was originally deposited in this old channel, and there it still remains except where swept away by the ice during the Glacial period.

Burwash [1] *and Tetamagouche Creeks.*—Burwash creek heads in the glaciers of the St. Elias range, and empties into Kluane river 5 or 6 miles below Kluane lake. It has a length, measured along its valley, of 18 or 20 miles and trends for a great part of its course across a high plain or platform-like surface that fronts the St. Elias range in this vicinity. Burwash creek is also a typical, swift, mountain stream, comparable in size with Bullion creek, but with a grade less than that of Bullion, amounting to about 125 feet per mile along the main, central portion of its course. Like all glacier streams, its daily and seasonal flow is extremely variable, depending on the strength of the sun; and in times of flood, it becomes a raging torrent.

From near its head to the point where it enters the valley of Kluane river the stream is bordered on the left by a mountain wall which rises abruptly in most places for over 2,000 feet from the creek bed. On the opposite or right-hand side (looking downstream), however, the creek is flanked throughout a great part of its course by the high plain, before mentioned, the surface of which is composed of glacial deposits. Into this glacial upland tract, and prevailingly along its extreme edge, Burwash creek has cut a deep, trough-like valley. Along most parts of its course, the stream channel is bordered on the left by a rocky mountain wall, and on the right by more gentle slopes underlain by detrital materials and covered with grass and underbrush. At a few points the stream flows through narrow rock-walled canyons which are difficult to penetrate except in low water. The canyons are the result of the stream at these points having become superimposed over rock spurs projecting from the mountain sides. Above the upper canyon, the valley of Burwash creek suddenly opens out, and has gently sloping grassy slopes reaching up from 30 to 80 feet to the upland surface of the glacial platform fronting the St. Elias mountains.

Downstream from apparently just above the upper canyon, Burwash creek, in the process of deepening its channel, slowly and intermittently shifted its course to the left until it reached its present position, with the result that there now occur in most places along the right side of the valley, a succession of rock-cut channels containing stream gravels, which represent former positions of the creek. These channels necessarily become gradually lower in elevation as the present creek bed is approached, but are now in most places covered with glacial and other superficial detrital materials. They have nevertheless been explored at certain points, where they have been found at no great elevation above the present stream.

Tetamagouche creek is the largest and most important tributary of Burwash creek, and joins that stream on its left bank either on or just above claim No. 60 above Discovery. The creek follows a rather straight southeasterly course through a break in the mountains which flank the left side of Burwash creek, and in the upper portions of its course occupies a somewhat open valley with gentle slopes clad with grass and underbrush. Nearer Burwash creek, however, it forces its way through a rock-walled canyon, so narrow as to be cleft-like in appearance.

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[1] McConnell, R. G., op. cit., pp. 15A-16A.

The rocks exposed along Burwash and Tetamagouche creeks are somewhat varied in character, but dominantly belong to an igneous, basic to semi-basic group including mainly diorites, diabases, andesites, basalts, and dunite—greenish and reddish amygdaloids being locally very prominent. In places, also, sedimentary rocks occur including for the greater part, shales, slates, argillites, cherts, limestones, and cherty conglomerate, in which Carboniferous and Triassic fossils were found; these beds have been intensely invaded by the igneous members. At a few points also, these older rocks are cut by granitic intrusives probably of Jurassic or Cretaceous age. All are pierced in places by dykes of a nearly white, greyish or yellowish rhyolitic rock which is thought to be of Tertiary age.

The creek gravels of Burwash and Tetamagouche creeks are in most places shallow, and are generally somewhat coarse. Along Burwash creek they are coarser, in most places, near the surface and also as the right bank of the valley is approached, most of the large boulders having rolled down from the hill side on the right bank of the stream. The bench gravels remain frozen throughout the year; but the creek gravels are only frozen in winter, and even then are in few places if anywhere frozen down to bedrock, remaining unfrozen at most points below a depth of 10 or 11 feet. This condition makes prospecting in the creek very difficult, owing to the difficulty of handling the water coming into the bottoms of the shafts.

From a mining standpoint, Burwash has been much the most important of the Kluane creeks, as more gold is believed to have come from the gravels of this stream than from all the other creeks of the district combined. Coarse gold has been found from the foot of the lower canyon upstream for a distance of 8 miles or more, but it is impossible to asertain the exact amount of gold that has been mined. From all the information available it seems probable that in all between $30,000 and $40,000 in gold has been obtained; and an additional amount of approximately $2,000 has come from Tetamagouche creek. The gold is characteristically very flat and well worn, that obtained from the benches being mostly coarse, and that from the creek much finer, and in places quite fine. Nuggets worth as much as $25 or $30 have frequently been found, but the largest known to have come from Burwash creek was found on claim No. 65 above Discovery. This nugget weighed 5 ounces, including less than one ounce of quartz and rock. The gold from this creek is all very pure, assaying generally from $18 to $18.10 per ounce.

About 40 claims were held on Burwash creek in the spring of 1914, and when visited by the writer, early in August, 14 men were working along the stream. The creek has been more or less prospected and mined from the lower end of the lower canyon up to No. 66 above Discovery. Above No. 66, one shaft was sunk to a depth of 21 feet, but with this exception practically no work has been done in the creek gravels, and there has been very little prospecting of the benches. The gravels of Burwash creek along the present stream have at a number of points yielded very satisfactory returns, and the channels along the right bank of the creek have been proved to contain gold in important amounts at several points.

The creek gravels, particularly above the mouth of Tetamagouche creek, certainly warrant further exploitation, and the old channels on the right bench deserve careful investigation. It would seem highly probable that there is still much gold along this creek, that can be mined at a profit. Mining operations to be successful, however, must be prosecuted carefully and under skilled and experienced management.

The gold that has been obtained from Tetamagouche creek has practically all been found below the canyon, and appears to be everywhere very "spotted" or unevenly distributed throughout the gravel. There are a number of points below the canyon where sluicing will still yield about $3 per day per shovel, an amount, however, that is considerably below the wage rate of the district.

Arch Creek.—Arch creek lies to the northwest of Burwash creek, and joins Donjek river from the right about 28 miles above the mouth of the Kluane river. It is a typical, swift, mountain stream comparable in length and volume of water with Sheep creek, and in many ways much resembling that stream.

The valley of Arch creek is a deep, steep-sided trough-like depression, the walls of which rise abruptly to the mountain summits on either side, which rise to elevations of over 2,000 feet above the mouth of the stream. In this depression as in others already described, vast deposits of boulder clay and other glacial deposits accumulated, and the consequent re-excavation followed. At two points, at least, the new channel became superimposed over rock spurs to one side of its former course, with the result that the stream, cutting downward very rapidly through these rock points, produced the narrow and cleft-like incisions, now known as the upper and lower canyons.

The lower canyon commences about 1½ miles above the mouth of the creek and extends upstream for about one mile. Above it the valley widens and, until the rock-walled upper canyon is reached, has more gentle slopes. Above the upper canyon, the valley again opens out, and the slopes are more gently inclined. The lower portions of the valley sides, except in the canyons, are in most places, deeply covered with glacial and other detritial accumulations.

The rocks exposed along the lower portion of Arch Creek valley are prevailingly sedimentary in character, and include mainly limestones, shales, cherts, and argillites. These are believed to be, for the greater part at least, of Carboniferous age; but some of the members may be older. The more massive limestones which appear to be the oldest beds exposed, resemble the Silurian beds on Sheep creek, and may be of that age. On the mountains to the south, Triassic beds were also identified. The sedimentary members along the creek have been invaded by an extensive group of igneous rocks including mainly diorites, diabases, andesites, and basalts, which are most strongly developed along the upper portion of the valley. All these older rocks are in places pierced by granitic intrusives which are thought to be of Jurassic or Cretaceous age.

Arch creek has been worked more or less since 1904, but although promising prospects have been found at several points in the lower canyon, only a small amount of gold has been obtained. Practically all the gold that has been found, so far as is known, was obtained from the lower canyon, within which the gravels are shallow and easily worked. Neither above or below this canyon, however, has bedrock been reached. During 1914 about 6 claims were held on this creek, all of which were located along the lower portion of the stream. When visited in August, Mr. R. W. and Mr. W. B. Lamb were engaged in sluicing immediately below the lower canyon in an attempt to reach bedrock, but although they had been so engaged most of the season, they had as yet not succeeded in penetrating to the bottom of the valley deposits. The main difficulty with which they had to contend, appeared to be the presence of numerous very large boulders, some of which were 6 to 8 feet or even more in diameter. These boulders, although associated with the recent gravels, are really a residue from the glacial deposits which have already been transported by the stream.

There is still undoubtedly some gold in both the upper and lower canyons, and in places it may possibly be in sufficient quantities to pay for mining. It would appear, however, that if placer gold in important amounts is found elsewhere than in these canyons, it will be mainly on or near bedrock in the old channel of the stream or, even probably, in portions of the present stream's channel where it has become superimposed over its former course. No gravels occurring in this position have so far been explored. Undoubtedly the two canyons represent very recent channels, and the position of the former course of the stream lies to one side of them. An old channel plainly lies to the left of the lower canyon, and the indications would apparently warrant the expense of prospecting and exploiting this channel and its continuation upstream. However, as in the case of all these intensely glaciated valleys, it is quite possible that the ice during the Glacial period may have swept away the gravels and whatever gold they contained. That gold occurred in the former channels of a number of the creeks of Kluane district is indicated by the fact that some gold, in places in important amounts, is found in the recent gravels, which represent a much shorter period of concentration than the gravels of the pre-Glacial channels.

Nansen District.

General Description.—Nansen creek is one of the headwater tributaries of Nisling river, and joins this stream from the north on its right bank. It flows in a general way almost due south and lies to the north of Aishihik lake and west of Carmack on Lewes river, the mouth of Nansen creek being about 30 miles from Carmack and about 29 miles from Aishihik village at the northern end of Aishihik lake, measured as the crow flies. The term Nansen district as used in this report includes only the area in the vicinity of Nansen creek, which was mapped by the writer during the past summer (1914). This district is about 10 miles long measured in a north and south direction, by 7½ miles wide. It includes all of Nansen and Victoria creeks with most of their tributaries, and embraces all the streams in that locality which have been found to contain placer gold.

Nansen creek to the mouth of Summit creek, has a length of about 9 miles, and Summit creek, which is really its continuation, has an additional length of about 1½ miles. It is a gently flowing stream with an even grade, and the volume of water varies considerably with the seasons, but is at no time very great. When visited in July, although higher up along the stream's course there was considerably more water, along the lower portions of the valley there was not sufficient to maintain the stream, and the only water in the channel consisted of occasional disconnected pools. The season, however, had been exceptionally dry. The relatively small amount of water near the mouth of the stream was largely due to the water sinking through the loose sands and gravels which overlie the boulder clay along this portion of the valley bottom. A mile or so higher up, there was 100 to 200 miner's inches or even more, and on the East Fork and on Summit creek, the two uppermost tributaries of Nansen creek, there was approximately 50 miner's inches of water. Several of the tributaries appeared to carry almost as much water as the parent stream below their confluence, showing that at different points along the creek there is loss of water from underground seepage.

Victoria creek is approximately of the same length as Nansen creek, being about 10 miles long, but it contains more water, possibly twice as much.

The valleys of Nansen and Victoria creeks are wide, flat-bottomed, typically U-shaped depressions with steeply inclined walls which rise to an upland surface having a general elevation of about 5,300 feet, the mouth of Nansen creek being about 3,700 feet above sea-level. Occasional summits rise a few hundred feet above the general upland, but throughout the district the hills are generally well rounded and have gentle slopes.

During the Glacial period, all the larger valleys of the district became partly filled with boulder clay and other glacial deposits which floor these depressions to near the heads of the streams. As the district, however, is situated near the edge of the glaciated zone in Yukon, the ice action did not extend more than a few hundred feet up the valley sides, and consequently the glacial deposits do not reach far above the present main valley bottoms. The tributary streams in most places, have deep, narrow, steep-walled valleys, the larger of which are in most places floored with at least a few feet of boulder clay overlain by other superficial detrital accumulations.

The district as a whole is very sparsely forested, but spruce trees sufficiently large for building cabins and for ordinary placer mining operations, grow in places in the valley bottoms, in some of the draws, and on occasional sheltered portions of the hillsides. A dense growth of underbrush from 4 to 6 feet in height, and consisting mainly of dwarf birch and willows, extends over nearly the whole district, including even portions of the upland surface.

The rocks exposed in Nansen district are dominantly igneous and metamorphic, and range from probably Pre-Cambrian to Tertiary in age. The southern end of the district northward to include portions of Webber and Dome creeks, is composed almost entirely of old schistose rocks—mainly mica schists, quartz-mica schists, and quartzite schists. These rocks belong to the Yukon group, [1] the members of which are extensively developed in Yukon and Alaska, and are almost undoubtedly of Pre-Cambrian age.

The geological formations exposed throughout the remaining more northerly portion of Nansen district, are practically all of igneous origin, and include three rock groups—an older basic to semi-basic group, and two more recent, acid groups which are genetically very closely related. The members of the more basic group are much the most extensively developed, and extend over the greater portion of the northern end of the district. They are apparently of Carboniferous or early Mesozoic age, and are all characteristically dark green in colour. They range in character from dense aphanitic rocks in which none of the mineral constituents are discernible to the unaided eye, to medium textured, holocrystalline members in which hornblende, biotite, feldspars, or other minerals are quite apparent, and include a number of types, mainly diorites, diabases, andesites, and basalts.

The more acid rocks are of two groups, a deep-seated or plutonic group of intrusive rocks that have prevailingly a granitic habit, and a related volcanic group including mainly granite porphyries and rhyolites. The granitic intrusives are greyish to pinkish in colour, and have the general appearance of granites. They cut the members of the more basic group, and are thought to be of Jurassic or Cretaceous age. The volcanic rocks appear to constitute, at least mainly, marginal or surface phases of the deep-seated granitic intrusives, but may in some cases represent later eruptions from the same parent magma. These acidic volcanics range in character from dense, cherty rhyolites to medium-textured granite-porphyries. The rhyolitic members of this group along the East fork of Nansen creek, and elsewhere are much silicified, and resemble cherts. They are, in fact, locally termed by the miners, "quartzites," but in places exhibit quite distinct quartz and feldspar phenocrysts. These rocks pass gradually into the more coarsely textured granite porphyries, which are generally light grey in colour, but like the rhyolites are in many places stained yellowish to reddish with iron-oxide.

Discovery of Gold.—Placer gold is believed to have been first found in Nansen district by Mr. Henry S. Back in July, 1899. Mr. Back had come from Selkirk on a prospecting trip with a partner, Mr. Ham. Kline, and found what he considered to be good panning on Nansen creek near the mouth of Discovery creek. After remaining in this vicinity two or three days, the partners continued on their journey, and no one is known to have further investigated the discovery, or to have found gold in the vicinity, until the spring of 1907, when Mr. Back returned with his son Frank H. Back and has since been identified with the district.

The first claim to be actually recorded was Discovery claim on Nansen creek, which was staked on June 13, 1910, by Frank H. Back and Tom Bee. Since that time mining and prospecting has been intermittently carried on in this locality. Practically all the creeks in Nansen district were at one time staked from end to end, but many of the claims were allowed to lapse.

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[1] Cairnes, D. D., "Geological section along the Yukon-Alaska Boundary between Yukon and Porcupine rivers": Bull. Geol. Soc. Amer., vol. 25, 1914, pp. 184-187.

Cairnes, D. D., "The Yukon-Alaska International Boundary between Porcupine and Yukon rivers": Geol. Surv., Can., Memoir No. 67, 1914, pp. 38-44.

Gold-bearing Gravels.—Practically all the placer gold that has been obtained from Nansen district has come from Nansen creek and from two of its tributaries Discovery creek and the East fork of Nansen creek with its tributary the South fork of the East fork of Nansen creek, these two forks or creeks being locally designated for convenience, the East and South forks, respectively. Prospects have been found on other tributaries of Nansen creek, as well as on Victoria creek, and on one or more of its tributaries, but no gold is known to have been mined from these streams.

Along Nansen creek, the valley bottom is floored with a thick deposit of boulder clay, overlying which is a covering, in places 20 to 25 feet thick, of sands, gravels, muck, and associated deposits. The gold that has been obtained, has been distributed through the gravels, in places being near the surface, and at other points being on or near the boulder clay—the "clay bedrock."

From Discovery claim which is just above the mouth of Discovery creek, about $1,200 to $1,500 has been mined, and on No. 7A above Discovery, Messrs. Printz and Delapola obtained 45 ounces of gold by ground sluicing from the surface gravels between August 5 and October 10, 1912. Other smaller amounts of gold have also been found, the total amount of gold obtained from Nansen creek being probably between $2,000 and $3,000.

From about claim No. 7 below Discovery up to Discovery claim, fine gold is known to occur in the gravel overlying the boulder clay, but the prospecting so far performed seems to show that it is not in sufficient quantities to pay for mining. This condition is due partly to the width of the valley, and to the consequent spread of the gold-bearing gravels over a broad area in places 200 feet or more wide. Gold is known to occur in important amounts also between the mouths of Courtland creek and East fork, where it has been found mainly at the surface, occurring mostly in certain small mounds or irregular wave-like piles of gravel.

During the winter of 1913-14, Messrs. Betterton and Morgan brought in a Keystone drill, and sunk 10 holes on or near Discovery claim on Nansen creek. The holes are reported to have all penetrated the boulder clay, but it is not known whether or not any of them reached actual bedrock.

On Discovery creek several claims have been worked or prospected, in some cases with encouraging results. Gold valued at $200 or $300 was obtained at the mouth of Eliza creek during the winter of 1912-13 by Messrs. Neilson, McDad and McLean. Also in the spring of 1912 Mr. George McDad, at a point about 1½ miles from the mouth of Discovery creek, sunk to bedrock, a distance of 18 or 20 feet, and crosscut from the bottom of the shaft. He obtained an encouraging amount of gold, the exact value of which is not known to the writer, but it is reported to have been about $300.

The largest nugget discovered in Nansen district was found by Messrs Neilson and McLean on Discovery creek and weighed just about one ounce.

It would seem quite possible that the bedrock channel in Discovery creek may contain gravels carrying important amounts of gold, but this channel has not been reached so far, unless in Mr. McDad's shaft and crosscut above mentioned. At the mouth of the creek the stream, since the retreat of the glacial ice, has become superimposed over a rock spur along the right or north side of its valley, and has there cut a narrow canyon through the greenstones, sufficiently deep to be on grade with the present surface of the valley bottom of Nansen creek. The former channel of Discovery creek plainly lies to the left (south) of this canyon and only a few feet distant from it. It would seem advisable to at least explore this easily accessible portion of the old channel.

The East fork of Nansen creek, to the mouth of the South fork, is covered by seven claims and a fraction. The lower four claims and fraction are owned by Messrs. Conrad Printz and E. L. C. Delapola, and the upper three claims, Nos. 5, 6, and 7, are the property of Mr. Albert Cristensen. All this ground along the East fork is thought to contain gold in paying quantities, and it is the intention of the owners to mine as soon as possible all that has not already been worked.

From the mouth of the East fork up to near the upper end of claim No. 4, the present stream gravels, which are the gravels there being worked, overlie boulder clay, the depth to this "clay bedrock" being about 6 feet. This ground has been worked by the owners by open-cutting and sluicing during portions of the past two summers. Mr. Printz claims that the gravels along this portion of the creek carry gold to the amount of about $1.50 per cubic yard.

Commencing at about the foot of Mr. Cristensen's ground, the boulder clay has been entirely removed from the channel of the present stream, and the gold-bearing gravels are on bedrock which is, along this portion of the creek, dominantly a highly silicified and chert-like rhyolite. Mr. Cristensen has been working his holdings intermittently for the past three years, open-cutting and sluicing in summer, and drifting in winter.

Along the portions of claims Nos. 5, 6, and 7, that have been worked, the depth to bedrock is from 10 to 20 feet, there being 4 to 6 feet of surface muck overlying the gravels. The gold is mainly on bedrock, and extends into cracks and crevices of the rock for 3 feet or more. The pay gravels where being worked when visited by the writer, were about 15 feet wide and carried about 40 cents in gold to the square foot of bedrock. Higher up, where the pay streak is only 12 feet wide, the gravels are claimed to carry 80 cents to the square foot.

In all, until July 1914, possibly about $2,000 had been obtained from the East fork, and the largest nugget found was worth $5.80.

Near the mouth of the South fork, Messrs. Miller and Shaw have been working during portions of the past three winters, and during part of last summer (1914). Their mining has all been done by the method of drifting on bedrock, hoisting from a shaft, and sluicing. The width of the pay gravels worked, ranges from 10 to 20 feet, and the depth to bedrock is about 20 feet. The bedrock there is a rhyolite similar to that lower down on the East fork where Mr. Cristensen is working, but in places is somewhat less silicified and cherty. During the winter of 1913-14 the owners obtained about $1,200 in gold from their operations, this being the clean-up from 4,500 8-pan buckets; in other winters they were much less successful. Some of the nuggets obtained are composed largely of a lustrous black telluride mineral, which occurs associated with the gold.

On Webber creek, three shafts have been sunk, 30, 22, and 40 feet, respectively, to bedrock, and gold in encouraging amounts is reported to have been found. When visited in July (1914) Mr. Courtney Mack was engaged in extensive ground-sluicing operations, in an attempt to strip bedrock by this method, and to cheaply and quickly handle the overlying, supposedly gold-bearing gravels. A section exposed there showed from 3 to 6 feet of muck overlying the boulder clay which extends down to bedrock.

On Back creek, a tributary of Victoria creek, Mr. John Rymar sank three shafts on claim No. 4 below Discovery, which are reported to have reached bedrock at depths respectively of 26, 26, and 30 feet. Gold in encouraging amounts is reported to have been found in these shafts and as a result, the creek has been for the greater part re-located—the claims having previously lapsed.

It is thought that in all, only from $5,000 to $7,000 in gold has been obtained from Nansen district; but systematic prospecting has been carried on at only a few points and it would seem possible that other valuable placer deposits may yet be found. Special attention should be devoted to the exploitation of the bedrock channels of the tributary streams, as although the amount of concentration may have been less in the small than in the larger valleys, the channels containing the gold-bearing gravels can be much more easily found along the tributary streams, than in the larger valleys; and, on the upper portions of the smaller valleys there was little or no ice during the Glacial period, and whatever gold was accumulated there in all probability still remains practically where it was originally concentrated.

Upper White River District.[1]

Upper White River district adjoins the 141st meridian which forms the Yukon-Alaska Boundary line along the upper portions of White river included within Canadian territory. From time to time for a number of years past, it has been reported that placer gold has been found within this area; the first authentic discovery that is known, however, was made on Pan creek during the winter of 1912-13 by Messrs. William E. James, Peter Nelson, and Frederick Best, who claimed to have found good gold prospects there, but stated that they were forced to stop work on account of the inflow of water when bedrock was reached. In the spring, Messrs. James and Nelson went farther west and became the original locators in Chisana district, Alaska.

During the autumn and winter (1913-14) following the Chisana discovery, prospectors rushed into Upper White River district, which is within about 30 miles of the original discovery at Chisana, and a great many placer claims were located, several streams, including Pan, Bowen (Dominion), Hidden, Cash (Gold), and Indian creeks being staked practically from end to end. The only creeks, however, on which gold sufficient to constitute promising prospects has been found, are Pan, Bowen, and a tributary of Bowen known as Hidden creek.

Pan creek is about 3½ miles long and drains over the southwestern side of Nutzotin mountains into Tchawsahmon creek. The valley of the creek is a deep, gorge-like, rock-walled incision, through which the stream, particularly along the lower portion of its course, rushes with great force, tumbling over a number of falls to reach Tchawsahmon valley.

The rocks exposed along Pan creek comprise both sedimentary and igneous members. The sedimentary rocks include mainly shales, argillites, cherts, greywackes, conglomerates, and limestones of Carboniferous or early Mesozoic age. These are extensively invaded by basic to semi-basic rocks including diorites, diabases, andesites, and basalts, which are thought to be, mainly at least, of about Cretaceous age.

The gravels along Pan creek are in most places narrow, and down to the edge of Tchawsahmon valley, are thought to be from 5 to 40 feet deep, except at or near the lips of the various falls along the stream, where bedrock in some cases is exposed. The gravels are very coarse, boulders several feet in diameter being very plentiful, and as they thaw in summer, and in winter are never frozen near bedrock, prospecting by sinking is almost impossible; consequently, the gravels on bedrock have nowhere been tested so far as is known. Some coarse gold has, however, been found in places along the rock rims of the creek channel, and in the gravels near the surface, so that further investigation is warranted. The best way to thoroughly test this creek would be to ground-sluice the gravels, fluming the surplus water when bedrock was being cleaned. In this way, with the volume of water in the creek at most seasons, it is quite feasible to strip the bedrock and exploit the overlying gravels, though the large boulders would be troublesome.

Three holes have been sunk in Tchawsahmon valley opposite the mouth of Pan Creek valley, the deepest of which is down about 90 feet. The ground encountered there was frozen to the bottom of the 90-foot shaft, where water was encountered and sinking was abandoned. None of the holes reached bedrock.

Prospecting in Tchawsahmon valley is not considered advisable at present for a number of reasons. The wide valley bottom—about one mile in width opposite the mouth of Pan creek—is floored with glacial and other superficial detrital accumulations to a depth of 100 feet or more, and there is no indication at the surface as to the position of any underlying bedrock channel, so that prospecting under such conditions would be very expensive and have little chance of reward. Besides there is no chance of finding the continuation of the bedrock channel of Pan creek within Tchawsahmon valley, nor of any of the streams tributary to this depression, as glacial ice has planed away the mouths of these tributaries and scattered the gravels with whatever gold they may have contained. Any gravels which were deposited on bedrock in Tchawsahmon valley, and which might have been gold-bearing, have also in all probability been also redistributed by the glacial ice.

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[1] Cairnes, D. D., "Upper White River District": Geol. Surv., Can., Memoir No. 50.

Bowen creek like Pan creek drains down over the southwestern face of the Nutzotin mountains, and empties into Tchawsahmon creek. This stream, as well as its tributary, Hidden creek, is in most respects much like Pan creek. Some coarse gold has also been found in them, but so far not in sufficient quantity to pay for working. However, very little systematic prospecting has been done in this locality.

COPPER DEPOSITS.

The only copper deposits that are known to occur in southwestern Yukon which have actually been mined or which under present conditions can be worked at a profit, are those in the Whitehorse Copper belt, near the town of Whitehorse. This area lies within the limits of the map accompanying this report, but was not examined by the writer during the past summer, as Mr. McConnell spent the summer of 1907 there and has written a very complete and exhaustive report [1] on the deposits.

Deposits carrying copper minerals have been found at a number of other points in the portion of southwestern Yukon dealt with in this report, mainly in Upper White River district, Kluane district, and in the vicinity of Aishihik lake. None of these deposits have yet been actually shown to be of economic importance, but some of them may be of value.

The copper deposits of Upper White River district, although possibly of future importance, cannot be exploited, until better transportation facilities are provided. These deposits have been described in detail in a memoir[2] recently written by the writer.

The copper deposits generally spoken of as the Aishihik lake, deposits which really occur on Gilltana lake,[3] a small body of water near by, and an isolated occurrence along Hutshi river,[4] a tributary of Nordenskiöld river, also promise to have future value, but under present conditions cannot be profitably mined.

The only other deposits of copper minerals known to be of economic importance, in this portion of southwestern Yukon, occur in the extreme northwest corner of Kluane district, in the vicinity of Quill, Burwash, and Tetamagouche creeks.

The area or belt through which these copper deposits are distributed, lies along the east side or left bank of Tetamagouche creek, and extends northward from Burwash creek to include the upper portion of Quill creek. Throughout this belt a great number of mineral claims have been located from time to time, commencing about the year 1908, but most of these have now lapsed.

The rocks are dominantly of igneous origin, although some sedimentary beds occur. The igneous members include mainly diorites, diabases, andesites, and basalts, certain reddish and greenish amygdaloids being particularly conspicuous. All these igneous rocks for convenience in description will in this report be referred to by the general term "greenstones." They are apparently of early Mesozoic or possibly of Carboniferous age, and very closely resemble the members of the "Older Volcanics"[5] in Upper White River district, with which the copper deposits are there associated. The sedimentary rocks include mainly shales, cherts, argillites, and limestones of Carboniferous or Mesozoic age, extensively invaded by the greenstones, the sediments occurring in most places as mere patches overlying the igneous members.

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[1] McConnell, R. G., "The Whitehorse Copper belt, Yukon Territory": Geol. Surv., Can., 1909.

[2] Cairnes, D. D., "Upper White River District": Geol. Surv., Can., Memoir No. 50, 1915 pp. 133-141.

[3] Cairnes, D. D., "The Gilltana Lake claims": Geol. Surv., Can., Sum. Rep. for 1908, pp. 30-31.

[4] Cairnes, D.D., "Mack's Copper": Geol. Surv., Can., Sum. Rep. for 1908, pp. 29-30.

[5] Cairnes, D. D., "Upper White River District": Geol. Surv., Can., Memoir No. 50, 1915, pp. 87-93.

Throughout this belt, copper minerals, mainly malachite (green copper stain) and also some azurite (a blue copper stain) and bornite are somewhat widely distributed, and occur associated with calcite, quartz, and epidote, in the greenstones—mainly in the reddish amygdaloids. These minerals either follow breaks or fault planes, or ramify through the rocks along irregular fissures, joints, or cracks. The copper and associated minerals replace the greenstones in which they occur, and in places the containing rocks are bleached to a nearly white or pale yellowish colour for 6 to 12 inches on either side of the mineralized fissures, joints, etc.

In places the rocks are only slightly stained along cracks, fissures, etc., in other places, calcite or quartz occurs associated with malachite, azurite, and bornite. The deposits are very irregular in form and distribution, and are usually not very persistent. The only sulphide noted in the belt is bornite, and the thickest deposit that is known to have been found carrying this mineral in any perceptible amount, has a thickness of about 4 feet. This deposit is situated near the summit of one of the highest mountains immediately north of Burwash creek, at an elevation of approximately 6,500 feet above sea-level or about 2,500 feet above the mouth of Tetamagouche creek. The deposit occurs in a reddish amygdaloid which is much altered, in places, to epidote and through it in places, streaks of almost pure bornite occur, from 1 to 3 inches in thickness. The remaining portions consist largely of more or less replaced wall rock with which is associated some calcite, quartz, epidote, malachite, and disseminated bornite.

Possibly the most important occurrence discovered in this belt, is that locallyknown as "Jacquot's." This deposit is situated at a point about 2,400 feet in elevation above the mouth of Tetamagouche creek, and occurs in a dark, dense, reddish basaltic rock which is in places amygdaloidal. The ore-material which follows a well-defined fault zone with a nearly flat dip, is from 12 to 24 inches in thickness, and consists mainly of bornite, malachite, epidote, calcite, quartz, and more or less replaced wall rock. An average sample, taken across the deposit at a point where it has a thickness of 18 inches, was assayed by the Mines Branch of the Department of Mines, Ottawa, and proved to contain: copper, 33·12 per cent, gold, none, silver, none. Stringers containing bornite are also exposed in the lower canyon of Burwash creek but are all less than 20 inches in thickness.

Although copper stain, associated in places with bornite, is so widely distributed, no deposit thicker than Jacquot's was seen, that contains nearly so high a percentage of copper. Very few of the deposits of any kind are more than 2 feet in thickness, and all that were seen are low grade and give little promise of containing much ore.

One locally well known occurrence, somewhat different from the ordinary type represented, is located about 1½ miles up one of the extreme headwater tributaries of Quill creek. This deposit consists of a reddish basaltic rock, amygdaloidal in places, throughout which for a width of 70 feet or more, green copper stain is somewhat evenly and plentifully distributed. An average sample was taken across the best 70 feet of this deposit, which was assayed by the Mines Branch of the Department of Mines, Ottawa, and proved to contain: copper 1·43 per cent, gold, none, silver, none.

None of the copper deposits that have so far been discovered in this locality could be profitably worked at present even under much more favourable conditions than now exist, as none of them are sufficiently extensive or persistent to afford any considerable tonnage of merchantable ore. However, as copper is so generally disseminated throughout the belt, it is quite possible that somewhere workable deposits will yet be discovered; therefore further prospecting is recommended.

COAL.

Measures containing valuable seams of coal, have for a number of years been known to be somewhat extensively developed in southeastern Yukon, mainly in three localities—Tantalus,[1] Braeburn-Kynocks,[2] and Whitehorse[3] coal areas, all of which have already been described somewhat in detail by the writer. Tantalus coal area extends along Lewes and Nordenskiöld rivers; Braeburn-Kynocks coal area crosses Klusha creek and Hutshi river, tributaries of the Nordenskiöld; and Whitehorse coal area lies a few miles to the southwest of the town of Whitehorse.

Two small areas of lignite-bearing beds, occurring respectively on Sheep creek and on Kimberly and Telluride creeks in Kluane Mining district, have been briefly described by Mr. McConnell.[4] In addition, a coal field, which contains a number of valuable seams of lignite of good quality, and is here designated the " Duke River Coal area," has recently been discovered in the northwest corner of Kluane district.

The lignite-bearing beds, which occur along the upper portion of Sheep creek, include mainly greyish sandstones, and conglomerates, grey to black shales, also occasional beds of tuff. These beds include several seams of lignite of good quality, one of which is at least 6 feet in thickness. An average sample taken across a seam, 3 feet thick, exposed in the lower or southeastern end of this Sheep Creek area, was analysed by the Mines Branch of the Department of Mines, Ottawa, and proved to contain:—

	Per cent.
Moisture..	10.9
Ash..	9.6
Volatile matter..	41.0
Fixed carbon (by difference)..	38.5

The rocks of the Duke River Coal area resemble those along Sheep creek, except that at the points where sections are best exposed and were examined, no tuff beds were noticed with the sediments. The beds of this area include mainly loosely or only partly consolidated black and greyish shales and clays, and yellowish to greyish sands and conglomerates, which include occasional intercalated seams of lignite. Fossil plants were collected from the beds of this area, and from those along Sheep creek; these after a preliminary examination have been forwarded to a specialist for more definite determination. They are, however, known to be of Tertiary age and they appear to indicate that the beds from which they were obtained, belong to the Kenai series[5] which includes the oldest known Tertiary sediments in Yukon and Alaska, and is generally referred to the upper Eocene.

The beds of the Duke River area are developed throughout a belt having a width of from 1 to 5 miles, which extends at least from Duke river to the Donjek, a distance of about 15 miles. Good sections of these rocks are exposed along the head of the left fork of Burwash creek, and along the left bank of a tributary of Duke river. At one point along this tributary of Duke river, a small sub-tributary has cut a huge amphitheatre about 1,000 feet deep into these beds, and along the walls of this great natural excavation, and extending up the sidehills above it, a section from 1,200 to 1,500 feet in thickness is exposed. In this vicinity the sediments have been little disturbed, and are practically flat-lying. They are imperfectly consolidated, and weather very readily, so that at a short distance they resemble ordinary unconsolidated Pleistocene or Recent deposits. Overlying them at this point are at least 500 feet of lavas and tuffs of Tertiary or Pleistocene age.

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[1] Cairnes, D. D., "Preliminary Memoir on the Lewes and Nordenskiöld Rivers Coal District": Geol. Surv., Can., Memoir No. 5, 1910, pp. 30-38, 48-55; also see map 10A.

[2] Cairnes, D. D., Geol. Surv., Can., Memoir No. 5, 1910, pp. 30-38, 49-50, also see map 11A.

[3] Cairnes, D. D., "Report on a portion of Conrad and Whitehorse Mining Districts, Yukon": Geol. Surv., Can., 1908, pp. 20-21.

[4] McConnell, R. G., "The Kluane Mining District": Geol. Surv., Can., Sum. Rep. for 1904, pp. 7A, 18A.

[5] Brooks, A. H., "The Geography and Geology of Alaska": U.S. Geol. Surv., Prof. Paper, No. 45, 1906, pp. 237-244.

Cairnes, D. D., "The Yukon Coal Fields": Trans. Can. Min. Inst., vol. xv, 1912, pp. 365-367.

These Tertiary sediments, where exposed in the amphitheatre, include at least 12 seams over 12 inches in thickness, that contain in the aggregate at least 30 feet and probably nearly 50 feet of lignite of good quality. The seams are distributed irregularly throughout the beds, occurring from top to bottom of the section.

Three samples of these lignites were taken. No. A is an average surface sample of 4 feet 6 inches of lignite exposed near the head of the left fork of Burwash creek. Neither top nor bottom of this seam was seen, the top having been removed by erosion, and the bottom not being accessible owing to its frozen condition. No. B is an average surface sample of a seam 4 feet 5 inches in thickness, which was exposed near the top of the huge amphitheatre on the sub-tributary of Duke river. No. C is an average of a number of pieces of lignite from 1 to 3 feet in diameter from a seam at least 3 feet in thickness outcropping in the amphitheatre. Owing to excessive weathering it was not feasible to strip this seam for a more satisfactory sample. These samples have been assayed by the Mines Branch of the Department of Mines, Ottawa, and proved to contain:—

—	A.	B.	C.
Moisture	10·2	11·2	9·8
Ash	9·1	5·4	1·6
Volatile matter	42·0	40·9	43·9
Fixed carbon (by difference)	38·7	42·5	44·7

GRAHAM ISLAND, BRITISH COLUMBIA.

(*J. D. MacKenzie.*)

GENERAL STATEMENT AND ACKNOWLEDGMENTS.

The field work of the writer during the season of 1914 on Graham island consisted of the completion of the detailed examination of the south central portion of the island, begun the previous year [1], and a general reconnaissance over the whole island. The excitement in regard to the occurrence of petroleum in western Canada during the present year had the effect of stimulating interest in the bituminous deposits of Graham island; in view of this circumstance an examination of these bitumen-bearing rocks was carefully made.

The time spent in the field extended from June 17 to August 18. During that period the district from Camp Wilson northward in the valley of the Yakoun river and its tributaries to the mouth of that river at Masset inlet was examined in detail. The shores of the expansion of Masset inlet, locally termed Masset Lake, were also carefully studied.

An important result of this detailed work was the accurate delimiting of the coal-bearing Cretaceous rocks in the vicinity of Camp Wilson.

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[1] MacKenzie, J. D., Sum. Rept., Geol. Surv., Can., 1913, pp. 31-54.

The reconnaissance work consisted of an examination of the western part of Skidegate inlet, left unfinished the previous year; a trip up the east coast from Skidegate inlet to Lawn hill, and thence westward across the northwestern lowland to the Yakoun valley; an examination of the Tertiary beds of Skonun point; and an examination of the north coast west of Masset inlet, the southern part of Langara island, and the west coast of Graham island as far south as Athlow bay.

The writer again wishes to express thanks for the assistance rendered by the Graham Island Collieries Company; the Graham Island Coal and Timber syndicate; the British Columbia Oilfields, Ltd.; Mr. J. H. Dawson, Mr. E. M. Sandilands, Dr. and Mrs. J. T. Wright, and very many others. The co-operation of Mr. Milnor Roberts, and those assisting him in the prospecting of the coal at Camp Wilson, Messrs. W. L. Barton, J. M. MacDonald, and Livingston Wernecke, it is again a pleasure to record.

The detailed field work was greatly facilitated by the excellent maps of the townships recently surveyed by the Provincial Government. For the reconnaissance work the charts of the coast line served very well.

The writer was ably assisted in the detailed mapping by Victor Dolmage, and C. E. Cairnes.

GENERAL GEOLOGY.

In order to make the notes that follow more intelligible the following condensed account of the general geology and table of formations is taken from the writer's summary report for 1913 with a few changes and additions.

The oldest formations exposed on Graham island are a series of metamorphic, volcanic, and sedimentary rocks, which have been considerably deformed in general, and are often extremely contorted in detail. These rocks which are of Jurassic and perhaps Triassic age have been intruded by stocks of diorite and quartz-diorite. Fossils are abundant in the metamorphosed sediments, and the rocks are correlated with the Vancouver group. The intrusive rocks probably are satellites of the great Coast Range batholith, supposed to be of upper Jurassic age.

On the rough, denuded surface of these older metamorphic and igneous rocks, a series of conglomerates, sandstones, and shales were laid down unconformably. These sediments are called the Queen Charlotte series, and in their lower portion contain coal-bearing horizons. The date of their deposition is placed in the Upper Cretaceous. The surface on which they were deposited was hilly, and often very uneven in detail. The general topographic conditions surrounding the basin probably resembled to some extent those found in the vicinity of Skidegate inlet to-day.

After, and perhaps to some extent during the deposition of the Queen Charlotte series, they were intruded by dykes and sills of volcanic rocks. These dykes and sills are up to 50 feet in thickness and occur abundantly in many localities. After the deformation and partial erosion of the Cretaceous rocks, extensive flows of volcanic rocks covered part of the island. Tertiary sediments occur in the northeastern part of Graham island, in places carrying lignite, and are thought to underlie the volcanic flows mentioned above. Erosion and denudation have greatly affected the slightly resistant rocks of the Queen Charlotte series, so that they now lie in several basins separated by ridges of the Pre-Cretaceous metamorphic and volcanic rocks.

During the Glacial period, the Queen Charlotte range was occupied by an ice-cap, from which valley glaciers flowed, scouring out the present fiords which are so characteristic a feature of the Queen Charlotte group. The large amount of glacial till in south central Graham island indicates that piedmont glaciers at one time occupied this area, while the occasional deposits of well stratified sands, gravels, and clays show that there was considerable deposition in lakes or estuaries of glacial origin.

Table of Formations.

Pleistocene and Recent	Superficial deposits.
Upper Miocene or Pliocene and probably Eocene	(Masset volcanics). (Skonun sediments). (Etheline volcanics).
Upper Cretaceous	Queen Charlotte series. Skidegate sandstones and shales. Honna conglomerate and sandstone. Haida sandstone and shales.
Upper Jurassic (?)	Batholithic intrusives. Quartzdiorite, diabase, etc.
Jurassic—Triassic	Vancouver group. Yakoun volcanics. (Middle Jurassic). Maude argillites and sandstone. (Lower Jurassic-Triassic [?]).

ECONOMIC GEOLOGY.

So far as mineral resources are concerned coal is the principal hope of the district examined. Lignite is a resource of probable future value. Besides coal, clay may be of some value, and possibly oil-shale. The chance that petroleum reservoirs may be found by drilling is regarded as extremely remote.

Coal.

In the vicinity of Camp Wilson is an area of about a square mile in which coal may be prospected for with fair hopes of success. It is virtually impossible to say more than this regarding the amount of coal and the structure of the seam until further drilling operations are completed. The workings at Camp Wilson were fully described, and analyses of the coal were given in the Summary Report for 1913.

Oil-shale.

The Maude formation contains numerous bands of dark brown to black, strongly bituminous rocks, resembling closely some varieties of oil-shale. Specimens of a typical "curly" oil-shale, light in weight, and containing a considerable quantity of bitumen, said to occur on the west coast, have been shown the writer. It is quite possible that oil-shale bands of commercial value may be found in the Maude formation.

Petroleum.

So-called "indications of petroleum" and "oil showings" have been found in several widely separated localities on Graham island, and the greater part of the island is staked for oil claims. It is proposed here to briefly describe the occurrences of bituminous rocks observed, and to point out why the conditions are not considered favourable for the occurrence of petroleum reservoirs. The oil rocks will be described in the order of their age, beginning with the oldest.

Maude Formation.—The possibility of the occurrence of oil-shales in the Maude formation has already been mentioned. In most exposures of the formation, but particularly on Hidden creek, Spirit river, King creek, and on Frederick island, films of black, odourless, sticky, tarry matter are found in joint cracks and on bedding surfaces. On Hidden creek, and elsewhere, gash veins of calcite up to several inches wide and usually only a few feet in length and irregular in distribution and orientation, contain sticky masses of the same black tar in small amounts. The finer bands of the formation are strongly bituminous, giving a marked smell when struck or rubbed; they are also highly fossiliferous, many laminae being literally crowded with flattened ammonites, in some cases as large as 15 inches in diameter. The only bituminous matter seen in the Maude formation is the black tar; nowhere have seepages of oil been observed.

Haida Formation.—In several borings made for coal in the Haida formation brownish films of oily matter have been found in the cores. These are seldom larger than a half-dollar coin; and in most cases can be traced to calcite veins intersecting the sandstones. Occasionally a harder pitch-like substance has been found in the veins in small amounts. At Camp Wilson, two of the boreholes gave small, but for a time continuous flows of gas, which gradually diminished. The gas was colourless and odourless, and burned with a smoky yellow, odourless flame, of low heat intensity. The estimated volume of flow was less than a cubic foot per minute.

Etheline Volcanics.—The only occurrence of petroliferous material in this formation was seen in a dyke cutting the Maude formation on King creek. This dyke, of pale bluish dacite or andesite, was vesicular, and some of the vesicles contained sufficient brownish-yellow oil to be visible, and to give distinct, oily films when a fragment was placed in water.

Masset Volcanics.—Bituminous matter in the Masset formation has attracted attention at several localities, notably at Lawn hill on the east coast, and at Tiahn point and Otard bay on the west coast. At Lawn hill, black pitch-like matter oozes from cracks in solid black basalt on the shore. The cracks are connected with narrow gash veins of calcite, many of which have a space in the centre filled with pitch. The amount of pitch is small, and appears only when the rocks are heated by the sun. The largest occurrences of bituminous matter are found at Tiahn point, on the west coast. At this place some of the basalt flows are strongly amygdaloidal, the amygdules varying from a fraction of an inch to 3 feet or more in length: the large cavities are more irregular in shape than the almond shaped smaller ones. The rim of the cavity is in nearly all cases lined with a pale bluish or greyish banded chalcedony. Inside of this occurs a lining of clear quartz crystals, and these usually leave a cavity at the centre of the anygdule, which is filled with black, odourless, sticky tar. The same sort of relation between chalcedony, quartz, and tar is seen in irregular gash veins. These veins vary in length up to several feet and in width up to several inches and are found cutting the basalt and the associated agglomerates. Here, as at Lawn hill, a warm sun brings the tar slowly oozing from the cracks in the rocks. The occurrence at Otard bay is essentially similar to the one just described.

Origin of the Tar.

The home of the bituminous matter, irrespective of its containing rock at present, is thought to be the Maude argillites, though an exception is possible in the case of the oil and gas in the Haida formation. Proofs of this statement are left to the forthcoming memoir on the geology of Graham island, where a much more complete discussion of the oil situation will be found.

Possibility of Reservoirs of Petroleum Existing.

There are four necessary geological features that an oil field must have in order to become productive. These are:—

1. *A supply of liquid oil*, of sufficiently low viscosity to flow through the pores or cracks in an oil sand at the temperatures obtaining where the oil is found.

2. *A container*, porous in itself, as in the case of a sandstone, or made so by fracturing or other changes, as in a shale, limestone, chert, or dolomite. This container, irrespective of its real composition, is termed the "oil sand."

3. *An impervious capping* over the oil sand, imprisoning the oil until it is released by the drill. The capping is usually shale.

4. *A rock structure* favourable for the accumulation of the oil in reservoirs from which it may be obtained when they are tapped with a drill.

Without going into the proofs here, it may be said that at no place on Graham island are all four of these conditions found together, and, so far as the writer could determine from a careful study, at no place are conditions one and four fulfilled. For these reasons, then, the possibility that workable bodies of petroleum may be found on Graham island is regarded as very remote.

YMIR MINING CAMP, WEST KOOTENAY DISTRICT, BRITISH COLUMBIA.

(*C. W. Drysdale.*)

The town of Ymir—the centre for the gold camp of the same name—is situated on the Nelson and Fort Sheppard railway 27 miles south of Nelson and 7 miles north of Salmo.

The Ymir mining camp is one of the oldest in British Columbia. In 1885, the Hall brothers, who two years later discovered the Silver King mine at Nelson, made locations near the headwaters of Wildhorse creek. In 1893, the construction of the Nelson and Fort Sheppard railway afforded easy access to the district. It was not until the summer and autumn of 1896, however, when the mining boom was on at Rossland, that prospectors began to pay attention to outside districts. It was then that mining activity really commenced at Ymir and among the many claims that were staked in 1896, were the Ymir, Elise, Dundee, Wilcox, Porto Rico, and others. In 1897, R. G. McConnell, now Deputy Minister of Mines, examined and reported[1] on the district in connexion with the preparation of the West Kootenay map-sheet.

For several years the camp had a comparatively steady growth free from mining booms and many of the properties then in operation have been working intermittently ever since, whereas others through complications in geological structure and for other reasons have been abandoned.

In order to aid in the mining development of this camp the writer was instructed to make a sketch topographical and geological map of the region during the field season of 1914, and to pay special attention to the working mines and deposits of prospective value. The area assigned includes the mineralized zones lying south of Halls, east of the crest of Quartzite range and north of Salmo. The west boundary of the map-sheet is about 5 miles west of the Nelson and Fort Sheppard railway and includes the Fern and Porto Rico mines.

The writer was ably assisted in the field work by W. J. Gray, of Vancouver. Indebtedness is felt towards the owners and superintendents of the various properties, in particular to Mr. Arthur Lakes, jun., of the Wilcox mine, Mr. W. A. Buchanan, of the Yankee Girl mine, Mr. B. H. Washburn, of the Dundee mine, Mr. J. J. Hennessy, of the Jennie Belle, Mr. E. Peters, of the Canadian Pacific railway and other groups of claims, Mr. W. B. DeWitt, of the Porto Rico, Mr. A. Burgess, of the Iowna, Mr. D. E. Grobe, of the Nevada and Commodore, Mr. Coleman, and others for many courtesies extended.

The memoir on the geology and ore deposits of Ymir now in course of preparation, will be accompanied by a sketch topographical and geological map on the scale of 1 mile to 1 inch.

Before commencing the Ymir work the writer spent three weeks at Rossland completing the field work for the final report on that camp. He also examined recent mining developments at Franklin camp on the North fork of the Kettle river. On the completion of the Ymir field work, some days were spent studying the geological structure of the ore deposits in the adjacent Sheep Creek gold camp as well as a molybdenite property on Lost mountain and copper properties up the North fork of Salmon river.

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[1] Summary Report, Geol. Surv., Can., 1897, pp. 31-32A.

AINSWORTH MINING CAMP, BRITISH COLUMBIA.

(*Stuart J. Schofield.*)

Ainsworth is situated on the east side of Kootenay lake about 2 miles north of its outlet into the Kootenay river. The camp has been known and worked spasmodically since 1883. During the season of 1914 a detailed geological study was carried on for a period of two and a half months, with the special purpose of aiding the mining industry. In this period many facts concerning the geology were collected which aided in the economic examination of the larger properties. It is proposed to complete the investigation during the season of 1915.

The writer is under obligation to the Consolidated Mining and Smelting Company for the plans of the underground workings of their properties, as well as for a plan of the mineral claims in the samp. Mr. Harold Lakes, Superintendent of the Silver Hoard, furnished a copy of the plans for this mine. V. Eardley-Wilmot, of Rossland, acted as geological assistant.

General Geology.

The sedimentary series at Ainsworth occurs on the eastern edge of a composite granite batholith which occupies the greater portion of West Kootenay. It consists of various kinds of schists with numerous interbands of limestones and quartzite all striking approximately north and south and dipping, on an average, 45 degrees to the west. Previous workers in this region have classified this series with the Shuswap (Archæan) Niskonlith, and Selkirk series (Cambrian to Carboniferous) and the Slocan series (Carboniferous), but from evidence obtained during the season of 1914 all the sedimentary rocks can probably be referred to the Beltian.

Intruded into the sedimentary series are small cross-cutting bodies of granite (field name) and numerous basic dykes of lamprophyric and aplitic habit.

Economic Geology.

The ore deposits of Ainsworth for the purpose of description, may be classified as follows:—

(1) True fissure veins.
    (a) Cutting the bedding planes at an angle.
        Highland, Florence, Early Bird.
    (b) Parallel to the bedding planes.
        Maestro, Banker.
(2) Replacement deposits in limestone.
    No. 1, Silver Hoard.

DESCRIPTION OF PROPERTIES.

Highland.—The Highland group occurs on Cedar creek 1½ miles northwest of Ainsworth, with which it is connected by wagon road. An aërial tram carries the ore from the mine to the mill at the mouth of Cedar creek on Kootenay lake. The deposits are true fissure veins, three in number, trending approximately northwest with a dip of 75 degrees east. The walls of the fissures have a horizontal displacement of 20 to 130 feet. The sedimentary series in the neighbourhood of the Highland mine consist mainly of siliceous limestone, quartzites, green schists, and quartzite in ascending order. This series is cut by mica and non-mica lamprophyre dykes generally parallel with the bedding of the sedimentaries. The ore consists mainly of coarse-grained galena and zinc blende with smaller amounts of pyrite and chalcopyrite in a gangue of quartz, ankerite, and fluorite. The ore-bodies occur in the fissures as tabular masses in the neighbourhood of the quartzite-green schist contact. As this contact dips about 45 degrees to the west, the ore bodies pitch in the same direction. The fissures are practically barren at no great distance from the contact. The recognition of this contact in the future development of the property is of prime importance.

Florence Mining Company.—The claims operated by the Florence Mining Company are located on Princess creek about 1½ miles northwest of Ainsworth. The country rocks on these claims are all sedimentary, consisting of interbanded siliceous limestones and mica schists striking north and south with a dip of 45 degrees to the west. The vein which cuts the above sedimentary series, strikes N. 65° W. and dips 60 to 75 degrees south; it varies in width from a few inches to 16 feet. This variation in width is due to the character of the country rocks crossed by the fissures. In the mica schists the vein is barren, but where it crosses the siliceous limestone a great enlargement takes place which is of the nature of a replacement deposit. Locally, these enlargements are called cross veins. The ore consists mainly of coarse-grained galena with subsidiary amounts of zinc blende and iron pyrites. The gangue is mostly quartz and silicified limestone. The future development of this promising property should be based on the above facts which show that although the vein pinches in the schists, it is good prospecting to follow closely the main fissure.

Maestro.—The Maestro operated under lease by the Consolidated Mining and Smelting Company, occurs about 3 miles southwest of Ainsworth at an elevation of 1,190 feet above Kootenay lake. The sedimentary series in the vicinity of the Maestro consists of alternate belts of quartzites and green hornblende schists striking about north and south, and dipping, on an average, 45 degrees to the west. The vein is of the true fissure type with a strike and dip concordant with the surrounding country rocks. This vein can be traced both north and south through several adjoining claims. The vein is entirely enclosed in the green schists near the contact with a belt of underlying thin bedded platy quartzites. The vein varies in width from 6 to 8 feet. The ore consists of coarse-grained galena with very little zinc blende in a gangue of quartz.

Banker.—The Banker claim operated by the Consolidated Mining and Smelting Company, is situated about 2½ miles southwest of Ainsworth, in close proximity to the Maestro. The country rocks on this claim are mostly massive and thin-bedded quartzites with interbedded green hornblende schists dipping north and south with an average dip of 30 degrees to the west. The deposit is a true fissure vein in the massive quartzites with which it conforms in dip and strike. The ore consists mainly of galena, both fine and coarse grained, in a gangue of quartz. The vein varies in width from 2 to 6 feet.

Silver Hoard.—The Silver Hoard mine is situated 7 miles by wagon road in a northwesterly direction from Ainsworth, and at an elevation of 4,300 feet above sea-level, or 2,540 feet above Kootenay lake. The ore occurs in two distinct zones in the Silver Hoard limestone, along its contact with the overlying argillite. The upper zone occurs at the contact with the argillites, while the lower zone occupies a position from a few feet to 20 feet from the upper contact. The ore which replaces limestone consists of galena, zinc blende, and native silver with a gangue of quartz, calcite, and fluorite. No oxidized ore zone exists. The structure of the Silver Hoard is identical with that of the No. 1 mine shown in the accompanying diagram. The ore zones, from the surface to the 100-foot level, dip to the west. Here a shallow syncline occurs which passes intoa gentle anticline. Between the 100-foot level and the 200-foot level, the ore zones change from a westerly dip to an easterly dip. Below the 200-foot level no information as to the structure is available, but it is probable the ore zones will resume their westerly dip at no great depth since the ore zones follow the folding of the rocks which, on the whole, dip at an angle of 45 degrees to the west.

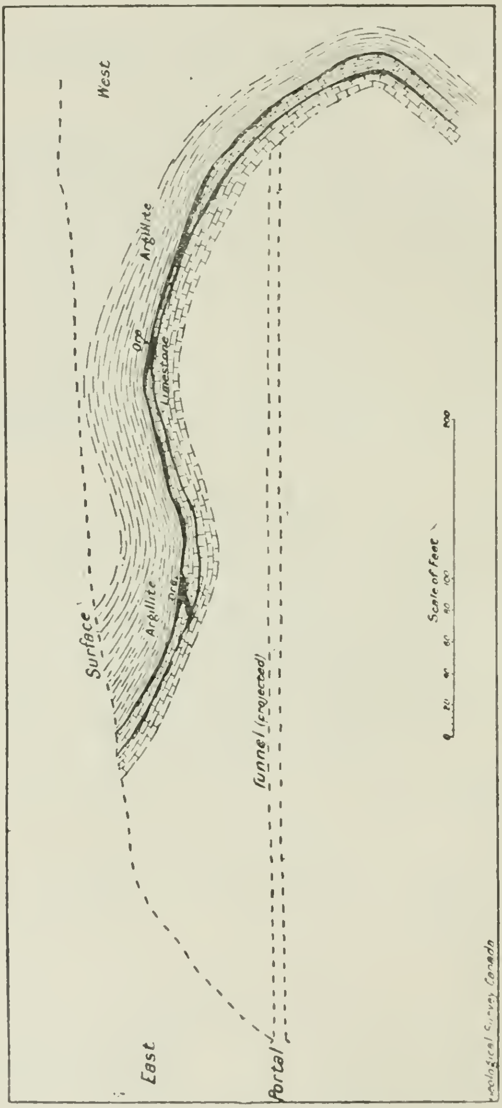

Figure 1. Diagrammatic cross-section of No. 1 mine, Ainsworth, B.C.

No. 1 Mine.—No. 1 mine is located 6 miles from Ainsworth at an elevation of 4,200 feet above sea-level, 2,440 feet above Kootenay lake. From the accompanying diagrammatic cross section it can be seen that the ore bodies occur as replacement deposits in limestone near its upper contact with argillite. The ore zones are two in number, one along the contact and the other from 7 to 20 feet from the contact. The present development lies entirely in the oxidized zone in which the ore occurs mainly as soft brown oxide of iron, impregnated with native silver and probably some carbonates and sulphates of lead. The structure of the No. 1 mine is very simple. The ore zone follows the bedding planes of the surrounding sediments and, as shown in the sketch, occurs in the form of synclines and overturned folds. The point of the overturn occurs between the first and second levels in the southern end of the property and plunges to the north so that in the northern part of the property the overturn is found between the second and third levels. This explains the fact that as one goes from the southern end of the property to the northern end the vein dips to the east, then becomes vertical, and in the northern end dips to the east. The vein on the third level dips to the east, but since the whole sedimentary series at Ainsworth dip to the west it is very probable the vein resumes its westerly dip at no great depth.

In depth also the ore will probably be found and pass into the sulphides of lead, zinc, and iron.

RECONNAISSANCE IN WEST KOOTENAY.

The relationships of the formations on the east and west side of Kootenay lake were studied during the months of June and July. After this period the investigation was continued by M. F. Bancroft, assisted by J. A. McLennan.

The purpose of the investigation was to work out the stratigraphy of the Selkirk series on the east side of Kootenay lake and its relationships to the Purcell series on the east and to the Selkirk series on the west side of the lake. Although the investigation was not completed, the results obtained prove that the rocks lying around Kootenay lake and mapped as Shuswap on the West Kootenay map-sheet are metamorphosed equivalents of the Selkirk series and hence are Beltian in age and that the series exposed in Ainsworth mining camp is mainly Beltian in age. The conformable relationships of the Selkirk and Slocan series at Ainsworth would, on stratigraphic grounds, place the Slocan series in the Beltian.

The facts collected as to the origin of the Kootenay Lake valley strongly support the idea that it is purely a valley of erosion. That the valley is due to linear faulting along the edges of the trench making it of a "graben" nature, is not tenable since no faults of this nature could be detected even in positions where field observations could be made with facility.

FLATHEAD SPECIAL MAP-AREA, BRITISH COLUMBIA.

(*J. D. MacKenzie.*)

LOCATION AND AREA.

The Flathead Special map-area is located in the valley of the Flathead river in southeastern British Columbia, near the International Boundary. The sheet is quadrangular, and is bounded by meridians and parallels. The southeast corner is near the northwest corner of lot 7339, about half a mile west of the Flathead river, 2 miles north from the 49th parallel. The length of the map-area is nearly 1¾ miles in a north and south direction, and its breadth is nearly 6¼ miles. The area is thus approximately 50 square miles.

REASONS FOR THE INVESTIGATIONS.

For a number of years it has been known that coal existed in the Flathead valley in several places, and lately considerable prospecting has been done on some of the coal areas. In order to ascertain the structure and probable value of what is generally considered to be the largest of these areas, the investigation now reported on was made. For that purpose a contoured map on a scale of approximately one inch to three-fourths of a mile, with a 50-foot contour interval, was made by the topographical division of the Geological Survey in 1913, and served as a base for the geological work.

SUMMARY OF THE WORK DONE.

Less than three weeks in the first part of September were spent in the field. In this time, the various formations exposed in the district were studied, their distribution mapped, and their structure determined.

The coal is found in a series of shales and sandstones which are correlated with the Kootenay formation. There are a number of seams, of which probably only three will be found to be suitable for mining. These are, however, of good quality, and one is at least 30 feet thick, nearly all good coal.

The coal seams have a general strike N. 25° E. and dip southeastward at various angles up to 60 degrees though not often as steep as this. The general structure is a downfolded, faulted monoclinal block, complicated by minor folds and faults.

ACKOWLEDGMENTS.

The writer wishes to acknowledge the assistance given by Mr. A. M. Allen of the Corbin Coal and Coke Company. Mr. E. W. Butts of Colgate was very helpful indeed, and furthered the progress of the work materially. Mr. O. V. Greene also gave valuable assistance, as did Mr. W. S. Earle. To all of these men, and to V. Dolmage and C. E. Cairnes, who gave efficient service as field assistants, the writer tenders his sincere thanks.

ROCKY MOUNTAINS PARK, ALBERTA.

(*J. A. Allan.*)

The field season extended from June 8 until August 2. During this time about 450 miles were covered with pack train in Rocky Mountains park, Yoho park, and adjoining districts. The work was of a threefold nature. It included a trip to Mount Assiniboine and westward across the Vermilion range to the Beaverfoot valley; the examination of a geological section along the headwaters of Blaeberry river over Howse pass down the Saskatchewan and over the Pipestone pass; and a traverse of certain trails that were followed by tourist traffic in Rocky Mountains park.

During the first part of the season a trip was made along Lake Minnewanka, through Devil's gap, up the Ghost river (north fork), and thence over to Cascade river. On this trip on the north fork of Ghost river, the overthrust fault that defines the eastern edge of the mountain system, was examined.

A second trip consisted of following up Spray river to Mount Assiniboine over the pass at this point, thence down Simpson and Vermilion rivers to the Kootenay, thence up the Kootenay and down the Beaverfoot to Leanchoil and Field. The chief object of this trip was to make another section across the Rockies in which it might be posible to ascertain the relations between the Ottertail formation, that is so highly contorted and metamorphosed where it is exposed on the line of railway, and the other Cambrian formations; also to work out the relation between the Cambrian on the watershed range and the Devonian and younger rocks further east. The section as worked out for the Ottertail and associated formations on the main line, corresponds to that found on Vermilion and Simpson rivers.

A trip was made also from Field up Amiskwi river, over the pass, down to Blaeberry river, thence up the valley of that river to Howse pass and down the middle fork of the Saskatchewan to the Kootenay plains, up Siffleur river over the Pipestone pass and down Pipestone river to Laggan. The object of this trip was partly to get information for a guide book to Rocky Mountains park and chiefly to verify the geological section on the railway, especially the relationship between the Intermediate limestone and the Sawback formation. From the data obtained it seems certain that the Sawback formation directly underlies the Intermediate, and is also of Devonian age.

SOUTHERN ALBERTA.

(*D. B. Dowling.*)

The activity in prospecting for oil through the foothill country west and south of Calgary necessitated a much closer examination of the structure of the country than had been attempted hitherto. In October, 1913, a short visit was paid to the vicinity of the first well and a hasty sketch of the section on Sheep river was subsequently published.[1] During the field season of 1914 S. E. Slipper who had remained in the vicinity all winter to collect samples from the various wells being drilled was entrusted with the further examination of the area included by the outer or Turner Valley anticline. The foothills south to the Livingstone river were examined by J. S. Stewart who reports on the folded belt behind the Porcupine hills north to the Highwood river. Sketch sections were also made across the disturbed beds on Red Deer and James rivers and on the Saskatchewan river by Bruce Rose. The writer's field work was done mainly in the vicinity of Calgary, but the first three weeks of the season were devoted to an examination of the Cretaceous measures in the Bad Lands of the Missouri and a comparison of the sections there with that along the Milk river in southern Alberta. In the following pages the results of this examination are briefly given.

Belly River Series and the Missouri River Section.

The divisions of the Cretaceous mapped by Dr. G. M. Dawson in southern Alberta are the following[2]:—

"*Fox Hill Sandstones.*—In some parts of the district well defined as a massive yellowish sandstone, but inconstant, and apparently often represented by a series of brackish-water transition beds between the Laramie and the Pierre.—80 feet.

Pierre Shales.—Neutral grey or brownish to nearly black shale, include a zone of pale, soft sandstone in the northeastern part of district, and frequent intercalations of harder sandstones, sandy clays, shales and clays.—Marine, 750 feet.

Belly River Series.—Composed of an upper or "pale" and a lower or "yellowish" portion, and consisting of alternations of sandstones, sandy clays, shales and clays.—910 feet.

Lower Dark Shales.—Grey to nearly black shales, with many arenaceous bands.—800 feet."

In the matter of correlation in the above divisions, there has been no controversy as to the correlation of the Pierre with the Bearpaw shales of northern Montana. It has, however, been claimed that the Belly River series is the same as the Judith River series. This is true in part only, the Belly River series appearing to include other subdivisions as well.

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[1] Memoir 52.

[2] Report of Progress, G.S.C., 1882-3-4, v. 112c.

The base of the Belly River series was described by Dawson as resting on a series of dark, marine shales having a thickness of 800 feet, as exposed in the vicinity of West Butte and on the slope of Rocky Spring plateau. Other exposures of a shale very similar in appearance which occurs near the bottom of the series were examined in two localities on the Milk river. The western one, which is not far west of the railway line crossing the river at Milk River station, was considered to be of Pierre age; and a thin cover of Pierre was mapped along the summit of Milk River ridge and down its eastern end southward to the boundary line. To account for its presence, it was assumed that an anticline occurred. In this mapping it would seem that the term Belly River series was restricted to include only the castellated sandstones of Milk river. The second exposure was found to the east of the low anticline in the castellated sandstones showing in the banks of Milk river near the outlet of Lake Pakowki. This exposure, since there was direct evidence that Belly River rocks lay above it, was placed beneath the Belly river and correlated with the Lower Dark shales, with the following qualifying clause.[1] " Before leaving this region it may be well to note that while the dark shales of the series exposed in the southeastern escarpment of the Rocky Spring plateau, closely resemble those seen in the flanks of the West Butte, their agreement is not so satisfactory with those of the Milk river north of the Middle Butte and at the mouth of the Pakowki coulée while on the hypothesis adopted, all these localities must represent a single lower subdivision."

This shale band, the lower dark shales at Pakowki, was identified by Stanton and Hatcher as the horizon named by them on the Missouri, the Claggett shale, both containing a fauna belonging to the Pierre rather than to the Benton. In the palæontological discussions of the fossils collected from these various exposures Dr. Whiteaves, without knowing that two horizons were here included, states that.[2] " Of the eleven species of fossils which have so far been collected from them, seven or eight seem to be identical with forms that are elsewhere regarded as characteristic of the Fort Pierre or Fox Hill group, but the presence in these shales of *Scaphites Warreni* var *Wyomingensis* and possibly *Ostrea congesta* may indicate that they occupy a slightly lower position in the series."

By separating the fossils found in the thick shales of Rocky Spring ridge and West Butte from the collection it is found that the Milk River exposures at both flanks of the anticline show only species that would be expected in the Claggett shales of the Missouri River section or in the Pierre of the Alberta section. It is, therefore, evident that these shales are not the equivalents of the shales that Dawson found beneath the sandstone series on Rocky Spring plateau, which he calls the Lower Dark shales beneath the Belly River series. The Benton age of these latter shales has been confirmed by Eugene Stebinger in a report to the U. S. Geological Survey.[3]

The same paper refers to the evident thinning of the shales above the castellated sandstones of Milk river and, apparently of those at Pakowki coulée correlated by T. W. Stanton with the Claggett. These shales, south of the International Boundary, are well developed east of the Sweet Grass hills, but to the west, in the regions of the Rocky Spring plateau, almost disappear and instead of a marine shale horizon are there represented by marine sandstones. The series described by Dawson as the Belly river thus seems to represent the following group of formations in the Lower Milk and Missouri River sections, viz.: Judith River, Claggett, and Eagle, and in western

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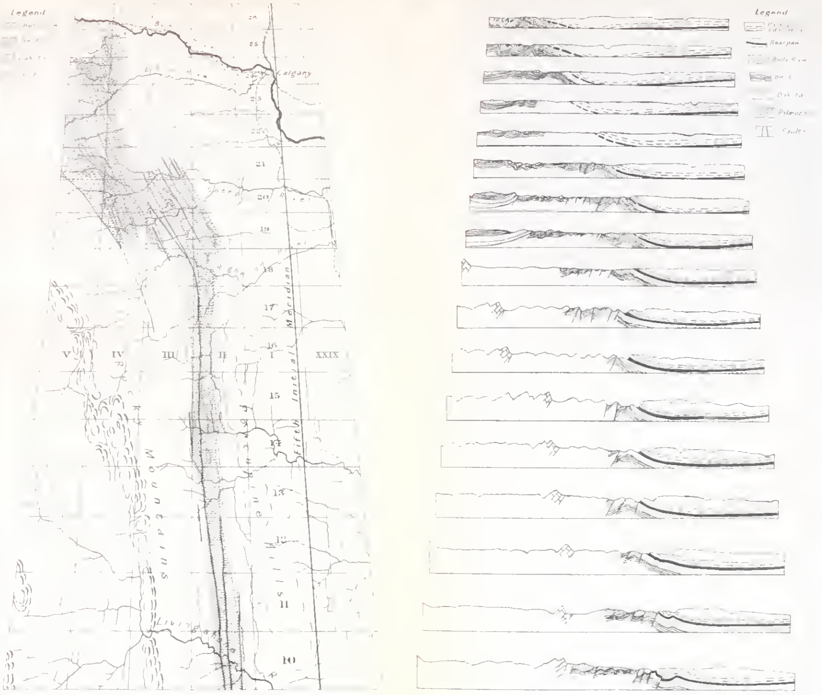
[1] Dawson, G. M. Rep. of Progress, 1882-84, p. 125C.

[2] Contributions to Canadian Palæontology, vol. 1, p. 78

[3] Professional Paper No. 90G, U.S. Geol. Survey.



Survey, Canada

Perspective diagram and structure sections, Foot-hills, Southern Alberta

Montana the Two-Medicine formation and the Virgelle sandstone. Between the two Medicine and the Virgelle or probably included in one of them are the shore deposits of the Claggett shales which are indistinguishable, except by fossils, from the Virgelle sandstone.

The divisions of the Belly River series north of the International Boundary in the vicinity of Milk river may be mapped as [illegible] belts sweeping around the north end of the Sweet Grass hills. The lower member the "Castellated rocks" of Milk river—which form the connecting deposits between the Virgelle sandstone of western Montana and the Eagle sandstone of the Missouri River section—consists mainly of brackish and salt water deposits toward the south, but brackish and possibly fresh water to the north. In its upper measures at least it is exposed along the Milk river and on the edge of the plateau running from the Rocky Spring ridge to near West Butte, and also in several of the gullies north of the three Sweet Grass hills. The sandstone is followed by an overlying band of shales exposed west of the town of Milk River and probably capping the hills to the east, where the coal horizons of its upper and lower members will probably be discovered. This shale band crosses the valley of Milk river east of Dead Horse coulée and continues south to near East butte which it skirts to the east. This series of shales is probably the equivalent to the Claggett, with an outlier on the north flank of West butte, and the sandstones above the shales which are exposed on the Milk river east of Pakowki coulée and in the country to the north and again in Milk River ridge represent the Judith River division—the Two-Medicine of western Montana.

Attention has been called to this area by the discovery of slight signs of oil in the Dakota (?) sandstones on the north slope of West butte and several drilling rigs have been erected on the flanks of West butte and in the valley of Milk river north of East butte. The drill at Milk river will probably have to pass through the sandstones of the lower part of the Belly River series as well as the whole of the Benton formation to reach the sandstones, possibly of Dakota age, beneath, which may contain gas or possibly oil. The thickness of the Cretaceous measures covering the possible gas or oil containers is appreciably less here than in the foothills.

The Foothills Area.

Considerable progress has been made in the study of the structure of the foothills. The area to which the most attention has been paid extends from Bow river south to Livingstone river, the north branch of Oldman river. Sections prepared by J. S. Stewart and S. E. Slipper were forwarded to the writer and a preliminary outline of the conclusions arrived at by these geologists. The structure is rather complicated in detail but may be made more intelligible by considering the folds and faults in a broad way to be the expression of the effect of a general lateral compression, the direction of which in the part from Oldman river to Highwood river was nearly east-west and in the country northward in a general east-northeast-west-southwest direction. The structure is most complicated in the area included between the Highwood and Sheep rivers, where the direction of the lateral pressure changed. To facilitate description a series of sections along the township lines crossing this disturbed area has been constructed by interpolations from the larger structure sections submitted by Mr. Stewart and Mr. Slipper. The sections which are shown on the accompanying diagram are placed opposite to the township lines to which they refer.

Notes on Diagrammatic Sections

In the upper part of the section to the right are the Tertiary sandstones, at the base of which are transition beds between Tertiary and Cretaceous. Beneath, shown in black, are the marine deposits of Upper Cretaceous age correlated with the Bearpaw of Montana overlying the sandy, brackish and fresh water beds of the Belly River formation, shown with lines of dots. The Colorado shales, which are very strikingly displayed in the northern part of the foothills, are shown by fine lining and in a few sections the underlying Blairmore (Dakota) sandstones appear, especially as a narrow band from township 14 to township 20, just west of the main eastern overthrust faults. The front range of the Rocky mountains is indicated by conventional block lining for limestones and between townships 10 and 14 it is evident from the section that the structure runs in nearly parallel lines. Long lines of hills on the strike of the rocks show the presence of the more resistant members. Northward the topography is more complex, the harder beds forming strike ridges and the trend changing to northwesterly.

WEST OF THE PORCUPINE HILLS.

In the southern part of township 10, at the eastern edge of the disturbed area, there seems to be a broken anticline in which the crown of the arch exposes the marine shales of the Bearpaw. To the east the sandstones, at the top of the Cretaceous, called elsewhere the Edmonton and St. Mary River beds, are exposed and continue as an easterly dipping member northward throughout the series of sections. The western limit of the broken anticline consists of sandstones very similar to those on the east side, but believed by Mr. Stewart to represent the Belly River series. The amount of displacement in these fault breaks appears to decrease towards the north and in township 15 seems to have about disappeared. The overthrust fault to the west of the sandstone ridge which forms the western limb of the anticline crosses the axis in township 15 and at the southern border of township 16 cuts off the anticline. Continuing northward the displacement to the west of this fault becomes greater and the Dakota sandstones are brought to the surface and form prominent ridges as far as the south branch of Sheep river at the mouth of Macabee creek. The fault on the east meanwhile breaks up into several branches. In township 18, the beds exposed on Highwood river, to the east of the outcrop of the Belly River rocks, become very much shattered and a zone west of the mouth of Bull creek shows exposures of Belly River and Edmonton rocks closely associated in narrow blocks separated by crumpled shales. This fractured zone seems to be connected with the fault west of the Turner Valley anticline in township 20, range 2.

SECTION OF OLDMAN RIVER.

(Based mainly on the work of J. S. Stewart.)

In this description the formations in the section will be treated in descending order, as they occur in ascending the river.

The Willow Creek Series.—The highest beds exposed on this part of the stream consist for the most part of light grey and light brown sandstones medium to coarse grained, in many cases showing cross bedding. The finer grained members often weather into thin paper-like layers. Some of the beds are quite calcareous but no limestone layers were seen. At the base, this series is composed of red, fine, sandy clays which, being quite unconsolidated and easily denuded determine the course of Callum creek and a considerable part of the Oldman river. The thickness of the whole series, allowing for cross bedding, must be at least 2,000 feet.

The Edmonton-St. Mary Series.—The base of the red clays noted above is made the dividing line between the Edmonton-St. Mary below and the Willow Creek beds above. These red clays appear to mark quite a change in the sediments and extend more than 12 miles to the north. The Edmonton-St. Mary is a sandstone series which has interbedded with the sandstone a few arenaceous shaly layers and also some nodular calcareous layers. At the base are a few thin coal beds. The series contains several beds of molluscs (unios) and some small gastropods, the two being often found associated in the same bed. The thickness here is about 3,000 feet.

The Bearpaw Shales.—The sandstone series just noted appears to grade into a shale series below, made up of dark soft shales with a few sandstone beds. The section observed was well exposed in only a few places. Fossils obtained from these shales included a few large ammonite forms and two varieties of molluscs. The thickness could not be ascertained.

The Belly River Series.—The Bearpaw shales can be seen to grade into light coloured sandstones below, but within a very short distance the regular succession is broken by a fault. The Belly River series is made up very largely of sandstones light-grey and pale-green in colour with interbedded bands of shale. A shale series with two coal seams lies about 1,000 feet from the base of the series. One sandstone bed about 150 feet from the base often weathers into hoodoo forms[1] where the dip is low. The total thickness of the series varies and appears to be greatest at the west, where it may be safely estimated to be at least 3,000 feet. Unios occur in several beds and fragmentary plant remains are also of frequent occurrence. Two fairly good impressions of leaves were collected.

The Benton Shales.—The Belly River sandstones grade into thin flaggy sandstones which become finer and finer in grain and darker in colour and gradually pass into an arenaceous shale. Only the upper part of the shale series that lies between the Blairmore formation (Dakota) below and the Belly River above, is exposed here. Following the usage along the Crowsnest pass this whole series is here included in the "Benton." The Benton shales are here badly crushed and folded; several marine fossils were observed in them but few could be collected as they almost invariably crumbled to pieces when disturbed. The fossils observed included *Inoceramus, Scaphites,* and some small coiled cephalopods. The thickness could not be ascertained as the downward extension of the series is cut off by a fault.

The Dakota Series.—(The Blairmore formation of Crowsnest river.)—The upper part of this series is not present. The lower part, about 1,000 feet, forms a synclinal basin at the western side of the section. The most common type of rock is an irregularly bedded, dark green, shaly sandstone. The coarser sandstones are usually light-grey to brown in colour. A very persistent conglomerate at the base forms an excellent horizon marker as it occurs over a wide area. The pebbles vary in size from about the size of plums to that of coarse sand grains, and are made up largely of black and greenish chert. The rock is strongly cemented and resists weathering well, so that wherever it occurs it forms conspicuous ridges.

The Kootenay Series.—Only the upper part of this series is seen. It consists of arenaceous shales which are in many places carbonaceous, sandstones, and coal beds. Many of the beds weather to the colour of iron rust. One seam of coal of workable thickness (4 to 5 feet) was observed, about 20 feet below the conglomerate noted above.

The Fernie Shales.—No sharp dividing line was observed between these shales and the Kootenay coal measures. The lower part of the Kootenay and the Fernie appear to be very susceptible to erosion and are almost always effectually concealed. In this section the Fernie shales are represented by calcareous carbonaceous shales. One of the beds yielded several belemnites; another, close by, is conspicuous for the odour of gasoline it emits on being struck with the hammer.

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[1] "Castellated rocks" of Milk river. See p. 45, line 7.

The Rocky Mountain Limestone.—This is the most conspicuous ridge and mountain maker of the region. The rock is a finely crystalline limestone with a very dense and hard surface. A few brachiopods were observed in it and a bed composed largely of crinoid stems. Extreme compression and crystallization has in many cases distorted and spoiled the fossils. The anticlinal structure shown in the section is inferred from observations both to the north and to the south, where the anticlinal structure can be actually seen.

SECTION ON WILLOW CREEK.

(Based mainly on the work of J. S. Stewart.)

At the eastern end of the section the rocks are practically flat lying. The division between Edmonton and Willow Creek series is here purely arbitrary. Exposures are few and the red clays which were used as a horizon marker on the section to the south, were not seen. The wide and conspicuous ridge of Edmonton sandstones to the south is quite narrow here and farther north it seems to die out completely. The ridge making members of the series have interbedded with them two bands of rusty weathering calcareous shale which are very resistant and persist for a considerable distance to the south. The area thought to be underlain by the Bearpaw shales is covered by a muskeg valley and the occurrence of the shales is inferred from the topography.

The Belly River series is represented by two low ridges which dip steeply to the east. The dip becomes more gentle at the base of the formation where gradation to the upper Benton shales may be observed. About 1,000 feet from the top, these shales show several bands with large concretionary nodules, calcareous and rusty weathering. Only one anticline (the easternmost) was observed, the one to the west is inferred.

The Belly River sandstones on the west side of the anticline rise rather abruptly and form a high ridge. The western part of the shale series is completely covered so that the relation between the shales and overlying Belly River sandstones cannot be made out. The abruptness of the ridge at the west side of the anticline valley seems to suggest the occurrence of a fault.

The fault shown between the Belly river on the east and the Dakota on the west is inferred from structures to the north and south of the section.

The lower Benton shales are dark grey in colour and include in places a few calcareous bands which weather rusty. One of these calcareous bands it was noted, yielded a decided gasoline odour on being struck with the hammer. The fossils include several small molluscs, large inocerami, and small coiled cephalopods. The thickness is about 1,100 feet. The shales are underlain and overlain by sandstones. The continuation of the upper sandstones appears to be broken by a fault. To the west of range 2 the outcrops are too scattered and the beds too much broken to allow of any reliable statement being made as to the structure without more detailed study. The Kootenay coal measures apparently brought up by a fault were actually observed.

SECTION ON PEKISKO CREEK.

(Based mainly on the work of J. S. Stewart.)

The Pekisko Creek sections have been compiled from several short sections and scattered outcrops rather than from one continuous section. No distinction has been made between Edmonton and Willow Creek series in this section, the dividing line between them could not be defined. The part of the Edmonton, which to the south is a ridge maker, appears here to have become more or less shaly and susceptible to erosion.

The Bearpaw shales exposed along the creek are composed of coal seams, coaly shales, some poorly cemented, light coloured nodular shales and sandstones. No marine fossils were observed in them and the well cemented dark shales are absent. The shales are underlain by eastward dipping sandstones (Belly River) but these are not well exposed. Between the Belly River exposure and the sandstones of the Blairmore formation (Dakota) there is a space occupied by a dry valley without exposures. The best section of Belly River rocks was found in a small tributary coulée in section 2, range 20. The rocks seen are sandstones which in a few beds are quite calcareous. In colour they vary from a greenish to a light brownish grey. One of the darker coloured beds contains a considerable amount of fragmentary plant remains. The section is incomplete and the thickness cannot be gauged.

Of the Benton shales, only a few scattered outcrops were observed; in all cases the dip was westward and mostly steep.

The Blairmore formation (Dakota) wherever identified is a sandstone series which shows a considerable variety in texture, but is generally coarse. The finer grained beds are almost invariably of a dark greenish colour. The series as a whole is generally lacking in fossil remains.

The faults shown in the section bringing up the Blairmore sandstones, are inferred both from the lithological succession and from the inconsistency of dips and often of strike also.

TURNER VALLEY ANTICLINES.

This anticline was brought into prominence by the discovery of light oil in the Dingman well. It has not been traced northward past the centre of township 21, where the structure changes; it dips slightly to the north and is broken by a series of faults. To the south the anticline can be recognized as far as Tongue creek, from which place it dips to the south and flattens out beneath the sandstones of the Porcupine hills. In the centre the shales exposed in Sheep river were at first thought to be the representatives of the marine shales of the top of the Cretaceous, exposed on the plains to the east and mapped under the name Pierre, but were later correlated with the Bearpaw of Montana. The thickness exposed, about 2,000 feet, does not accord with that of the Bearpaw formation behind the Porcupine hills, between Livingstone river and Highwood river, which there seems to have a thickness of only about 750 feet. The general lithological character of the Sheep River beds, although agreeing very well with that of the Bearpaw to the east does not agree altogether with that of the exposures to the south on Highwood river which contain coal layers that are absent in the shales on Sheep river. S. E. Slipper, who has been doing the detailed geology, and the writer have both concluded that these shales near the Dingman well are the upper part of the Colorado formations, and that the oil so far found has been from sandy beds in the Benton and Blairmore formations.

JUMPINGPOUND SECTION.

An area of the disturbed beds crosses the Sarcee Indian reservation, but it has not yet been examined in detail. A section, however, has been observed on Jumpingpound creek, and although the Bearpaw shales were not seen in place, a series of shales with coal seams very much folded was found west of Towers ranch. These probably belong to the upper part of Belly River formation, which forms the ridge at the western edge of the township, around the north end of which the stream flows. The rocks in the bed of the stream above the bend for about 6 miles show an anticline in the shales below the Belly River formation. This anticlinal structure follows the general direction of the folding in this part of the foothills, but minor flexures and possible breaks crossing the main anticline in directions nearly northwest and southeast seem to indicate that the valley cut out for Elbow river below this point followed a fracture or folded zone which was easily denuded. Bow river in its earlier stages may have followed a course farther south than at present as the portion of its valley between Calgary and Cochrane appears to be newly excavated. The anticline on the Jumpingpound has attracted the attention of oil seekers and two wells have been started on it.

ECONOMIC GEOLOGY.

In the foothills proper, the rocks exposed belong mainly to the lower part of the Upper Cretaceous. In addition to structural material, including building stone, cement, and brick making materials, the minerals of economic importance found in them are mostly fuels—coal, mineral oils, and gas. All three of these have been discovered and large outlays in time and money have been made in their exploitation. The work of the present season was directed mainly to the study of the structure of the outer part of the disturbed belt, mainly with the object of definitely fixing the horizon from which the oil was obtained and also to locate suitable anticlines in which the depth to the oil sands would not be excessive.

Coal.

In the foothills immediately in front of the outer range of mountains, an area not directly examined this year, there are known outcrops of the Lower Cretaceous measures and there the Kootenay formation although thin, is known to contain some coal seams. In the outer foothills the sandstone formations near the top of the Cretaceous in places contain coal seams. The horizons that are the most promising for the occurrence of coal are the top of the Belly River series and the beds at the base of the Edmonton that are more properly referred to the St. Mary formation. These horizons are separated by the marine beds of the Bearpaw formation. Small coal seams have been found in the vicinity of the outcrops of this shale band which is located in a well-defined valley, lying west of the Porcupine hills and extending north to Highwood river. Outcrops occur on branches of Oldman river and Willow creek. A much contorted area on Highwood river, exposing the upper part of the Belly River formation, contains a seam of fairly good coal that has been mined with some success in the southern part of township 18, range 2. The seam is very much broken up and is made valuable only because of the extra local demand for drilling. The continuation of this horizon north on each side of the Turner Valley anticline is indicated by exposures of coal in sec. 15, tp. 19, range 2, and at Black Diamond in sec. 8, tp. 20, range 2, on the east side, and at Lineham post-office, on the west side of the anticline. The same horizon crosses Jumpingpound creek in secs. 19 and 30, tp. 25, range 4, where small coal seams outcrop. In the area lying farther to the west, the Belly River series becomes more bituminous and workable seams have been found on both branches of Sheep river and on the Elbow river. The most accessible exposure is near Morley on the Indian reserve, which is referred to by Mr. Cairnes in the Moose Mountain report.[1]

Oil.

The discovery of a light oil in this district was announced in the Summary Report of this Department for 1913. The oil was obtained in the No. 1 well of the Calgary Petroleum Products Company, familiarly known as the Dingman well. It is situated on the crown of the Turner Valley anticline, on the south branch of Sheep river. The anticline is flanked on both sides by ridges of sandstone. These were at first supposed to be referable to the Edmonton formation, and the shales in the centre of the anticline were thought to be the Bearpaw or the highest marine formation in the Cretaceous; but since the marine character of these shales is doubtful and the whole formation almost unrecognizable, it is now believed that the marine shales in this anticline are the upper part of the Colorado formation, and that the sandy beds passed through in the drilling are sandy members of the Benton. One of these beds encountered at a depth of 1,550 feet, contained a small supply of light gasoline oil, gravity 62 degrees Baume. Further boring penetrated the shale series to a depth of about 2,100 feet and at 2,700 feet oil was found in sandstones believed to be of about the age of the Dakota. This was of gravity 55 degrees Baume and was accompanied by a fairly strong flow of gas, which had also been obtained at other horizons in the well. Oil is not being pumped from this well as at present the gas pressure is sufficient to blow out enough to supply the local demand.

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[1] Memoir 61, Geo. Sur., Can.

Another discovery of oil was made on November 24, 1914, in the Moose Mountain well, on an anticline between the Elbow and Jumpingpound rivers, in sec. 34, tp. 23, range 5, W. 5th mer. The shales on this anticline are of Benton age and the Dakota sands were reached at a depth of 1,690 feet. A dark green oil of 40 degrees Baume was bailed out and the question of a commercial supply is being investigated by shooting the well preparatory to pumping.

Showings of oil are claimed in several of the wells in Turner valley, and there is reason to hope that other oil wells may be found to be productive.

Gas.

Several of the wells being drilled in the search for oil have yielded flows of gas. The gas in the Dingman well, which is best known, has the following composition according to an analysis made by the Bessemer Gas Engine Company, of Grove City, Pennsylvania:—

Heavy hydro-carbons by claroline oils	36·00%
" " less 11·25% air	40·00%
Carbon dioxide	1·50%
Oxygen	2·25%
Sp. gravity	0·81%

Estimated yield of "liquified petroleum" marketable as gasoline: 1 gal. per 1,000 cu. ft. Estimated basis 250 lbs. pressure 70° F. condensing.

(Sgd.) JOHN McGUN, JR.,
Chief Chemist.

An experimental condensing plant has already been installed and small amounts of a very light oil have been obtained.

During the year gas has been obtained in other localities also, notably in the vicinity of the Battle River anticline near Viking on the Grand Trunk Pacific railway, about 75 miles east of Edmonton. The reported flow was 9,000,000 cubic feet per day, but it is claimed that the flow gradually decreased, indicating that the gas came from a small reservoir at a depth of 2,340 feet, evidently in the Dakota sands.

More than 190 companies were formed for the exploitation of oil leases in this district, but of these only about 44 are doing actual drilling in the area south and west of Calgary.

RECONNAISSANCE ALONG THE RED DEER, JAMES, CLEARWATER, AND NORTH SASKATCHEWAN RIVERS, ALBERTA.

(*Bruce Rose.*)

The discovery of oil in the Dingman well on Sheep river south of Calgary, led to widespread prospecting for oil in the foothills country of Alberta. Most of the claims were staked south of the main line of the Canadian Pacific railway, but some attention was given also to the district west of the towns of Olds and Red Deer and it was thought advisable to secure field information that would aid the oil prospector and show where it would be best to prosecute further geological work.

Accordingly, a reconnaissance survey along the foothills streams of this district was undertaken. Sections were made in an area which from a structural standpoint might afford prospecting ground for oil. These, in each case, extend from the comparatively undisturbed Paskapoo-Tertiary sediments westward into the folded and faulted Cretaceous rocks of the foothills.

A period of seven weeks, beginning August 1, 1914, was occupied in field work and during this time R. C. Hargrave gave efficient assistance. A brief description of the sections follows.

Red Deer River.

A section along the Red Deer river from the centre of range 6 to the centre of range 8, was examined. The rocks are grey sandstones, grey-green shales, and carbonaceous shales with a few small coal seams. These rocks are folded and faulted and the strike of the folds and faults is in general parallel to the trend of the Rocky mountains to the west. No attempt is made to separate them into formations, but they belong as a whole to the Upper Cretaceous series.

The geological structure over the greater part of this section is not of a character to make the field a promising one for the occurrence of reservoirs of oil. There are, however, a few open anticlinal folds that present more promising structural conditions. On one of these lying west of the Paskapoo sandstones in sec. 5, tp. 32, range 6, W 5th mer., the Monarch well has been sunk. A depth of 3,600 feet was reached without getting oil; but there is a considerable flow of gas from the well.

An anticlinal fold crosses the Red Deer at the range line between ranges 6 and 7. From there westward no open folds occur to a point just west of where the Morley trail crosses the river, where, at about the range line between ranges 7 and 8, an open anticline is well exposed on the north side of the river. From there to the end of the section examined the rocks dip to the southwest.

A telemeter plane-table map of the section from the Monarch well to the mouth of Williams creek, was made. The remainder was examined without mapping.

James River.

The section mapped on the James river extends from the range line between ranges 7 and 8, west and south, to the township line between townships 32 and 33.

For the first 2,000 feet, the rocks are yellow sandstones dipping gently eastward. These are thought to belong to the Paskapoo formation. For the next 5 miles, the rocks are grey sandstones and grey green shales, similar to those on the Red Deer river. There are a number of open folds in these rocks and this part of the section is structurally the most promising for oil borings. Next, there is a black shale formation, containing orange coloured clay-ironstone nodules arranged in bands along the stratification. No similar rocks were seen along the valleys to the south or north. These shales extend for approximately 4 miles, but are so much folded and faulted that they do not offer good ground for boring operations. The remainder of the section consists of mixed shales and sandstones dipping to the southwest, with a few local folds in the shales, and is of the same unpromising character.

Clearwater River.

The Cretaceous rocks are not exposed along the Clearwater river. From the last outcrops of the Paskapoo sandstones westward to the Palaeozoic limestones of the Rocky Mountains overthrust, the banks of the river are gravel covered, so that it is impossible to tell what the structure of the underlying rocks is.

North Saskatchewan River.

The rocks along the North Saskatchewan river were examined from the junction of the Clearwater river at Rocky Mountains House, westward to Shunda creek, a distance of approximately 40 miles. They are grey sandstones and grey-green shales throughout with some carbonaceous shales and a few coal seams. They probably all belong to the Edmonton formation.

For the first half of the distance examined, the rocks are flat-lying, but in sec. 34, tp. 39, range 10, W. 5th mer., a fault is exposed on the north bank of the river. To the west of the fault the rocks dip southwest at an angle of 25 degrees and at the fault the Alberta Associated No. 1 well is located. The dip of these rocks gradually becomes lower and 2 miles farther on the beds are again flat. They continue flat for approximately 13 miles but gradually become tilted to the northeast, thus forming a broad shallow syncline. The northeast dip continues to within a short distance of Shunda creek. Here two open anticlinal folds are well exposed on the south side of the river. This is the only location of the whole section where the structure is favourable for boring.

THE SHEEP RIVER MAP-AREA, ALBERTA.

(S. E. Slipper.)

The field season of 1914 was devoted to the mapping of the Sheep River Special map-area, which includes townships 17, 18, 19, 20, and the southern half of 21, in ranges 2 and 3, west of the 5th meridian.

The field was brought into prominence by the discovery of oil in 1913, and since then many companies have been actively engaged in boring operations. The geological structure being extremely complicated, it was deemed advisable to have a map prepared in some detail, so that a comprehensive idea of the structure would be available.

The sheet comprises 314 square miles. Telemeter traverses, using the township surveys for control, were run over the greater part of the area. Except along the banks of the main drainage channels, the country is covered with superficial deposits, and hence, geological work resolved into carefully traversing the sections on Sheep and Highwood rivers, and expanding the data thus obtained over the remaining territory. Particular pains were taken to note and study structures which seemed favourable to the accumulation of oil.

The work was carried on under the supervision of D. B. Dowling of the Geological Survey staff, whose advice assisted in solving the different problems presented.

The writer is indebted to the following gentlemen for information and other courtesies: Mr. S. K. Pearce, Mr. A. W. Dingman, Mr. Joseph Sinclair, Mr. C. W. Dingman, Professor J. C. Gwillim, Mr. J. S. Stewart, and others. C. H. B. Cooper and S. J. Davies acted as assistants in a very efficient and energetic manner.

THE FOOTHILLS AREA, WEST OF THE PORCUPINE HILLS, ALBERTA.

(*J. S. Stewart.*)

During the field season of 1914 the writer was engaged in geological investigations in the foothills country of southwestern Alberta. The area covered by the work lies to the north of the Crowsnest Pass railway between the Livingstone range and the Porcupine hills, embracing tps. 10-17 inclusive, ranges 1, 2, and 3 W. 5th mer., and ranges 29 and 30 W. 4th mer.

The work was advanced by the efficient aid of the assistants, A. E. Cameron and L. W. Gould. The writer also had the advantage of the general supervision and helpful criticism of D. B. Dowling. Thanks are due the ranchers along the routes traversed for kindnesses and information received, which furthered our work.

The object of the investigation was to determine if possible the detailed stratigraphic sequence of the anticlinal structure which extends southwards from the vicinity of Black Diamond, where boring operations for oil have been in progress, and further, to learn if there were any stratigraphic units persistent and distinct enough to form horizon guides.

General Character of the Area.

The conspicuous features of the area are the Livingstone range on the west and the Porcupine hills at the east. The intervening country is characterized by a series of north-south ridges; these ridges and intervening valleys are caused by alternating bands of hard and soft rocks which are in some cases repeated by faulting and folding. The relief is sharp, 500 to 1,000 feet of rise being not at all uncommon. Many of the hills are grass-covered and the valleys, even along the stream channels, have in many cases the bed-rock concealed by a mantle of gravel or clay. Wide valleys and small streams are the rule. The master streams flow in a general east to southeasterly direction, cutting the ridges more or less at right angles.

The Livingstone range presents rather a steep face to the east, rising to an altitude of about 7,000 feet. It is more or less even crested and generally devoid of sharp peaks; the crest line is, however, often narrow and knife-like.

The rocks of the region are entirely sedimentary, and range in age from Carboniferous at the west to late Cretaceous and Tertiary at the east. By far the larger part of the area, however, is underlain by rocks post-Dakota in age and among which no bed appears to be sufficiently continuous and uniform to serve as a safe horizon marker.

Structural Geology.

The whole region has been affected by the Laramide Revolution and the subsequent disturbances which, with erosion, have produced the present Rocky mountains.

The strata have a general strike of about 5 degrees west of north, the making of structure sections which was the main part of the work was, therefore, in an east-west direction. Location was obtained by means of telemeter traverses which were tied to fixed points wherever possible. A rapid reconnaissance showed that the rocks of the eastern part of the area are practically horizontal, while those of the western part are intricately folded and faulted; attention was, therefore, confined largely to the folded part of the area. Traverses were run and the structure studied at intervals of about 6 miles, or more frequently where a promising stretch of outcrops offered. None of the sections, however, shows a complete stratigraphic succession, step faulting in places having destroyed the natural sequence. The best section obtained was that along the north fork of the Oldman river, which has entrenched itself in a wide gravel-filled valley. This section from west to east shows for the first 10 miles almost a continuous series of western dips and for the most part at high angles. In the western part there is evidence of a marked thrust fault which caused the Kootenay coal measures to override the Belly River sandstones for about a mile. A few of the most typical structure sections have been submitted to Mr. D. B. Dowling for approval and incorporation in his report on the region as a whole.

Economic Notes.

Besides the Kootenay coal, which is very persistent, coal occurs in at least two other formations, the Belly River and the Edmonton. In these two latter formations, however, the seams show extreme variations in thickness within short distances, this being probably due largely to the irregular distribution of the mountain-making stresses. Practically all the coal mined in this area is taken out by ranchers and is for local use.

In the area covered by the work, prospect holes for oil were being drilled by three companies: the Associated Oil Company in sec. 7, tp. 16, range 2; the Sterling Company in sec. 15, tp. 17, range 3; the Calgary Alberta Company in sec. 34, tp. 17, range 3. At the time these were visited, early in September, the drills had in no case penetrated more than 200 feet.

A seepage of inflammable gas occurs in sec. 20, tp. 15, range 2, while to the north along the strike in sec. 31, tp. 16, range 2, there is a cold spring through which hydrogen sulphide gas bubbles at frequent intervals.

AN EXPLORATION OF THE REGION BETWEEN ATHABASKA AND GREAT SLAVE LAKES, ALBERTA AND NORTH WEST TERRITORIES.

(Charles Camsell.)

INTRODUCTION.

The field of the writer's operations during the season of 1914 lay in the region between Athabaska and Great Slave lakes east of Slave river and in the basin of the Talston river. This region lies partly in the provinces of Alberta and Saskatchewan, but mainly to the north of these provinces in the Northwest Territories. It embraces a block of territory over 50,000 square miles in extent, stretching from Slave river eastward to the Dubawnt and Thelon rivers and north from Athabaska lake to Great Slave lake. The only information that we had of this region is contained in Samuel Hearne's account of a journey across it from west to east in the winter of 1772 as he was returning to Hudson bay from his voyage of discovery to Coppermine river.

Our work was purely of an exploratory nature, its purpose being to obtain information on the geography, geology, and natural history of a region about which we had previously very little knowledge.

The party consisted of eight men in three canoes. The members included Francis Harper, naturalist, and A. J. C. Nettell, geological and topographical assistant. The canoemen were mostly Ojibway Indians from Garden River, Ontario.

We left Athabaska May 19, in a large scow, and were accompanied down Athabaska river and as far as Athabaska lake by two other Geological Survey parties under A. G. Haultain and F. J. Alcock, who were to make geological and topographical surveys of the shores of Athabaska lake.

At Fort Chipewyan a delay of ten days was occasioned by ice in Athabaska lake and on June 12 a short trip was made with Mr. Alcock to examine a small area of so-called Huronian rocks on the shore of the lake about 40 miles northeast of Chipewyan.

Later in attempting to secure a guide for the trip into the region north of Athabaska lake, we were again delayed at Chipewyan for several days, so that it was June 24 before a start was finally made from that point, and even then we were compelled to start out with no other assistance than a rude sketch drawn by an Indian, of the route it was proposed to follow.

The original plan was to try and reach the headwaters of the Thelon river and to descend that stream to the Hanbury river returning to Great Slave lake by way of Artillery lake and Lockhart river. This route, though feasible, was abandoned because of the lateness of the season and the lack of a guide. The only alternative route through the region was by way of the Tazin and Taltson rivers.

This route into the region leaves the north shore of Athabaska lake at the bottom of a large bay about halfway down the lake and about 3 miles west of the mouth of Charlot river. From here a series of five short portages, with a total length of nearly 3 miles, from one lake to another, leads into Tazin lake which is on the north side of the height of land and drains to Great Slave lake. From Tazin lake the route lies down Tazin river through Thainka, Hill Island, and a number of other lakes to the mouth of Tazin river at its junction with the Taltson, crossing the route of Hearne's traverse at Hill Island lake.

The Taltson river was then followed down to its outlet in Great Slave lake. Short excursions from the main route were made at different points, the longest being to Thekulthili lake which lies about 20 miles north of Hill Island lake. The total distance travelled on the route was about 300 miles.

Taltson river enters Great Slave lake about 60 miles east of Fort Resolution and the shore of the lake was followed to this point passing through the delta of Slave river.

Fort Resolution was reached on August 21 and after spending a few days in the examination of certain lead-zinc deposits near by and collecting fossils from the Devonian rocks exposed on the shore of the lake, the return journey by way of the Slave and Athabaska rivers was begun on September 1. At Chipewyan the other Geological Survey parties rejoined and the united party returned to Athabaska reaching that point on October 10 and Ottawa on October 18.

From Athabaska lake to Fort Resolution a survey of the route was made by compass and Massey, floating, boat-log, the distance being checked by latitude observation whenever possible. This method was found to work very satisfactorily because of the peculiar character of the stream and the fact that the route lay almost north and south.

The progress of the work was greatly facilitated by the hearty co-operation of all the members of the party. Residents of the district, namely, officers of the Hudson's Bay Company, other fur traders, members of the Royal Northwest Mounted Police, and others, aided us greatly by advice and other assistance. We are, however, especially indebted to the Forestry Branch of the Interior Department for the use of the Fire Patrol steamers on the Slave and Athabaska rivers, by the use of which we were saved a great deal of time and hard work in ascending the rivers on the return journey.

GENERAL CHARACTER OF THE DISTRICT.

The basin of the Taltson river and its tributaries lies entirely within the great Laurentian Plateau region or, as it has often been called, the Canadian Shield, and its physical features of land and water are characteristic of the great region that comprises the northeastern part of the continent. It is a country, when viewed on a large scale, of rounded outline and moderate relief, but in detail it is rugged, broken and rocky and somewhat difficult to travel over. It is a country also of numerous rock-bound lakes and of clear-water streams flowing in ill-defined and irregular valleys.

The highest elevations in the region travelled are along the immediate shores of Athabaska lake where the hills rise somewhat abruptly to a maximum height of about 800 feet above the lake or about 1,500 feet above the sea. From these hills, the surface slopes gradually and regularly northwest to Great Slave lake, the elevation of which is given as 520 feet above the sea. In consequence of this general character of the region the height of land lies about 3 miles north of Athabaska lake and the average slope from there to the mouth of Taltson river at Great Slave lake is about 6 feet to the mile and that without any decided break at any point.

The Taltson river follows the slope of the land surface, but like most rivers in the Laurentian Plateau region it has no well-defined valley nor has it an evenly graded profile. It is characterized rather by a succession of level stretches and short sharp falls. Here and there for considerable stretches its valley is well-defined and regular, but more generally it flows from one expansion to another through narrow gorge-like openings at which there are as a rule direct falls or strong rapids. For the greater part of its course, it flows through a rocky country on which there is little or no soil, consequently there are few gravel beaches and the river itself is clear and carries no sediment. Within 30 miles of Great Slave lake, however, it enters an alluvial plain which has been built up in the past by Slave river, and is a part of the ancient delta of that stream. Here, the river cuts a shallow valley in the old delta deposits exposing sections of sands and silts.

The Taltson river drains practically the whole region between Athabaska and Great Slave lakes east of Slave river as far as the 108th meridian. Its main tributary is the Tazin river. The Tazin drains the country immediately north of Athabaska lake, and the Taltson the country between the east end of Great Slave lake and latitude 61 degrees, its headwaters interlocking with those of the Thelon river which flows to Hudson bay.

The Tazin and the Taltson rivers at their junction are of almost equal volume, each having a discharge, when measured on August 1, of about 6,000 cubic feet per second. The discharge of the Taltson river itself, measured at a point about 20 miles from its mouth, was calculated to be about 13,000 cubic feet per second.

The Taltson river cannot be considered a navigable stream and steamers could only ascend it to the first falls, a distance of about 20 miles. Falls and strong rapids occur at frequent intervals throughout its whole length, and in our descent of the stream from Tazin lake to Great Slave lake it was necessary to make about forty portages, the longest a mile in length, and to run dozens of rapids.

The country abounds in lakes, all of them remarkable for the clearness of their water and the beauty of their surroundings. The largest of these are: Tazin lake, 25 miles long and 7 miles wide; Hill Island lake, about 21 miles long and 2 miles wide; Tsu lake, 15 miles long; and Thekulthili lake, a lake which we did not thoroughly explore, but which is probably 25 miles long. They are nearly all rock basins, with irregular shore-lines and few beaches.

Over the greater part of the region the bedrock has no covering of soil or loose material. Here and there sand plains or patches of boulder clay occur and towards the mouth of the river the bedrock has been covered by sediments from Slave river. On account of the lack of soil there are no possibilities for agriculture even if the climate were more temperate. The forest trees are small and stunted and no commercial timber can be said to occur anywhere in the whole region. The principal trees are spruce, Banksian pine, poplar, birch, and tamarack.

The lakes and streams abound in whitefish, pike, suckers, and lake trout. Other game, however, is scarce except in the winter season when cariboo come into the region in great numbers from the Barren Lands. Besides these, there are a few moose and black bears. All the fur bearing animals common to the Mackenzie River region are found here.

The country is inhabited by Indians known as Caribou Eaters, a branch of the Chipewyan stock who trade at Fort Smith. A few Indians, however, from Chipewyan, Resolution, and Fond du Lac hunt over parts of it.

The commercial possibilities of the region are small, and it is not likely to support any population except possibly such as might be engaged in mining pursuits. Agriculture is out of the question and unless economic minerals are found in it, it will always remain virtually unsettled. So much of this block of territory remains to be explored that it is impossible to say yet what it may contain in the way of minerals. Quartz veins were noted in a belt of slates, limestones, and schists at Hill Island lake, and this is the only portion of the region traversed that it would seem to be worth while to prospect. These veins may possibly prove in places to be gold bearing.

GENERAL GEOLOGY.

The geology of the region along the route of the traverse between Athabaska and Great Slave lakes is summarized in the following table which is arranged in chronological sequence beginning with the most recent.

Recent	River deposits, lake beaches.
Pleistocene	Glacial deposits (sand plains, moraines, and boulder clay).
	Unconformity.
Pre-Cambrian	Athabaska sandstone (?) (conglomerate).
	Unconformity.
	Post-Tazin granites and gneisses.
	Intrusive contact.
	Tazin series (mica, chlorite and quartzose-schists, slates, limestone).

The name Tazin series is a new name introduced for convenience in describing a series of rocks that cannot yet be correlated with any of the established Pre-Cambrian formations.

Recent and Pleistocene.

Recent deposits, such as lake beaches and stream deposits, are very sparingly developed throughout the region except in the neighbourhood of Great Slave lake where the Taltson river cuts through the eastern edge of the delta of Slave river. Higher up the river there is little loose material over the surface of the country from which to build these deposits.

Glacial deposits too are not widespread and indeed a very large proportion of the region has no surface covering of loose material but has its bedrock exposed. The glacial deposits occur only in isolated areas, never of very great extent or thickness, consisting of patches of boulder clay, sand plains, and terminal moraines.

Athabaska Sandstone (?).

A small area of rocks belonging presumably to this formation occurs at the north-east end of Tazin lake, in the form of a shallow syncline resting on the older gneiss. It consists of red conglomerates and sandstones dipping at a very low angle and striking almost east and west.

Another area of this formation probably also occurs at the eastern end of Thekulthili lake, for the western shores of the lake are strewn with many blocks of a like sandstone carried there by glacial action.

Post-Tazin Granites and Gneisses.

Rocks of this series cover by far the greater part of the route between Athabaska and Great Slave lakes. They extend from Tazin lake to Hill Island lake with only a few breaks, but from Hill Island lake northward to Great Slave lake they form an unbroken belt which is traversed by the river for about 180 miles.

They consist of hornblende granites, biotite granites, and granitoid gneisses made up of similar constituents. Rocks of different ages are grouped under this head, for some of the massive varieties are clearly later than the gneisses and intrusive into them. The strike of the gneisses is not constant but the most common direction is about north and south, and it varies through an arc of 20 degrees on either side of this.

These rocks are clearly older than the Athabaska sandstone and wherever they are in contact with the Tazin series they are intrusive into them. It is possible, however, that some of the older gneissic varieties may be older than the Tazin series, though no evidence of such a relationship was obtained.

The Tazin Series.

This is a series of schists and true sediments occurring in five or six distinct bands separated from each other by the batholithic bodies of granite or gneiss.

One band of these rocks extends from the shore of Athabaska lake along the route of our traverse over to Tsalwor lake. What is probably the extension of the same band is again encountered on Tazin river at Thainka lake where it is only about 2 miles wide. The band strikes about N. 55° W. and the beds of which it is made up, dip at very high angles. Another band occupies the west bank of Tazin river for about 9 miles in what is known as the Long Reach. These two bands are composed of chlorite, mica, and quartzose schists and they are clearly intruded by granite gneiss.

An important band consisting of interbedded limestones, slates, and mica schists occupies almost the whole of the basin of Hill Island lake. The individual beds are usually less than one foot wide and stand vertically. They strike north and south parallel to the trend of the lake. This band also is intruded by granite gneiss and near the contact its rocks are traversed by a great many quartz veins, which may prove to be economically important.

A fourth band occupies the north shore of Thekulthili lake at its west end. This is a greenish conglomerate with apparently a volcanic matrix, striking N. 55° W. and dipping 40 degrees to the north. This also is traversed by quartz veins.

A fifth band only about 1 mile wide occurs about 6 miles below the mouth of Tazin river. This consists of garnetiferous mica schists very much disturbed and metamorphosed by the granite gneiss which has intruded them.

What are probably remnants of the Tazin series in the granite batholith are found on the east shore of Tsu lake and in one or two other places. These are narrow bands and lenses of garnetiferous gneiss, mica schist, iron ore, and pyroxenite, all very much disturbed and showing no regular alignment. They are usually only a few feet across and are completely surrounded by granite gneiss.

ECONOMIC GEOLOGY.

The probability of discovering minerals of commercial importance along the route of this traverse is not great and the only formation in which these may occur is the Tazin series. This series along its contact with the granite gneiss in places contains a great many quartz veins especially on the west shore of Hill Island lake. These may possibly prove on careful prospecting to carry gold ores in sufficient quantity to repay working, but the locality is at present so remote that the veins would have to be exceptionally rich.

The Tazin series also contains small quantities of iron ore, but in no place was it found in sufficient quantity to be considered important.

GLACIATION.

One of the most marked features of the region is the evidence of the intensity of the glaciation and the freshness and unweathered character of the rock surface as a result of glaciation. The rocks are everywhere rounded, grooved, and striated and even in the beds of streams, where erosion and obliteration of glacial markings would be expected to be very rapid, striæ still remain. In general, the region is characterized by glacial erosion and removal of material rather than by glacial deposition. Such deposits as boulder clay, moraines, drumlins, and sand plains are not as widespread as in the region farther south and west, consequently the streams have little sediment to carry.

The general direction of movement of the ice has been about S. 62° W. with variations to one side or the other of this direction due to local irregularities of the surface. There is also some evidence of a later and more feeble glaciation, the striæ of which show a more northerly trend.

GEOLOGY OF THE NORTH SHORE OF LAKE ATHABASKA, ALBERTA AND SASKATCHEWAN.

(*F. J. Alcock.*)

The summer of 1914 was spent in mapping the geology of a band of country of varying width lying along the north shore of Lake Athabaska. The object of the work was to study the geological problems of the country, and more particularly to examine the mineral resources of the region and to report on the mineral claims which have been staked there.

The journey to the field was made with Charles Camsell and A. G. Haultain, of the Geological Survey, Fort Chipewyan at the west end of the lake being reached on June 3. Work was begun at the east end of the area where the Carp river empties into the Stone or Black river. The work was of a reconnaissance nature, and mapping was done by ascending streams by canoe and by land traverses varying in number and length according to the importance of the country and its accessibility. The mineral claims were examined, and at several places traverses were made on the south shore to study the Athabaska sandstone and to determine if possible whether the sandstones found on the north shore could be correlated with it. Actual field work on the area was completed on September 16. The journey from the field was made with Mr. Camsell's party and Edmonton was reached on October 12.

The writer wishes to make especial acknowledgment to Mr. Percy Abbott, of Edmonton, who was most courteous in showing specimens of ore from his mining claims on the north shore of the lake and who also very kindly furnished a copy of the assays which he had had made. Assistance in the field was rendered most efficiently by W. S. McCann.

The following summary of the formations is only tentative. The rocks are all Pre-Cambrian:—

Athabaska sandstone.
    Unconformity.
Tazin Series.
Granites and gneisses, some of which are post-Tazin.

The Athabaska sandstone is a flat-lying, yellow and reddish rock, heavily cross-bedded, exposed on the south shore of Lake Athabaska, and showing in places a vertical section of over 400 feet. On the north shore it is redder in colour, and in places becomes a coarse conglomerate lying unconformably on the formations beneath. No fossils were found in it, but its lithological characters and the fact that it is cut by diabase dykes indicate that it is probably Keweenawan.

The Tazin series is exposed in three main areas, and smaller patches of it are found at various places on the north shore. The largest area is that along Beaverlodge bay, where it is developed for 16 miles along the shore and extends back at least 10 miles to the north. It consists of limestone, quartzite, slate, and sandstone. The limestone is bluish in colour, weathering to rusty brown and occurs only in local patches cut by gneiss. The quartzite is much the most abundant type in the series. It is white and in places reddish, is very badly brecciated and in several localities contains considerable hematite. The second area is found on Slate island and the neighbouring mainland. Here the series consists of schists of a dark grey and brown colour, and of a conglomerate with rounded boulders up to 2 feet in diameter, in a matrix of green chloritic material. The quartzite is well developed on the mainland near Slate island. The third main area of the Tazin series occurs as a narrow band in the neighbourhood of Sand point, and runs parallel to the shore. It consists of white brecciated quartzite and to the east of Sand point there is a locality where the beds of quartzite are separated by thin beds of schist. Cliffs of quartzite and clastic schist border the shore for 2 miles between Sand and Big points.

A series of rocks of somewhat different character to the prevailing types occurring in the Tazin series is found in the region of the Cypress river. The dominant rock is a dense, red, highly altered arkose or a volcanic tuff. This set of rocks may represent an older series or it is possible that it may be correlated with the Tazin series.

Much the greater part of the region is underlain by hornblende, biotite and muscovite granites and gneisses which show all degrees of foliation. Some are clearly younger than the sediments of the Tazin series, but others may belong to an older complex. Gabbro, norite, amphibolite and diabase intrusives are found cutting the gneisses and sedimentaries, the most common type of intrusion being along the foliation and bedding planes. In places the intrusives themselves are foliated.

Economic minerals found were graphite, hematite, and pyrrhotite. The graphite occurs disseminated in certain of the gneisses but not in sufficient quantities to be commercially important. It was found at various places from Beaver river east to the Narrows.

The hematite is found in the Tazin series in the area around Beaverlodge bay and some years ago a number of mining claims were staked on it. The hematite consists of bedded deposits associated with the quartzite, but there has been a great amount of secondary deposition with the formation of veins of hematite in fractures and joints in the quartzite. An analysis of the hematite showed 66·7 per cent iron, but the amounts seen were entirely too small to be of economic importance.

A number of claims have been staked for nickel on iron-stained outcrops which have the nature of fahlbands in the gneiss. In a number of these, pyrite and pyrrhotite were found but in very limited amounts. In places in the norite at the east end of the lake, pyrite and pyrrhotite are found disseminated, and along certain fracture zones there has been concentration enough to produce a prominent iron cap, but in no case was sufficient ore seen to warrant development work. Of a number of assays of pyrrhotite ore, only one showed nickel in workable amount. Many of the claims staked were never recorded and of those that were, only six are now held, and on these no development work has been done. Further prospecting, however, may lead to the discovery of something more promising than has yet been found.

THE CRETACEOUS SECTIONS ON THE CROWSNEST RIVER, WEST OF THE BLAIRMORE SHEET, ALBERTA.

(*F. H. McLearn.*)

At two localities in southwestern Alberta, from which fossils have been recently collected by the writer, the passage from Benton-Niobrara into Belly River does not appear to be the normal one. The marine Claggett apparently is absent. Since this may be a condition typical of the whole southwestern Alberta region, a preliminary description of the sections studied is presented below. Until the fossils are determined a fuller treatment cannot be given.

Leach recognized the abnormality of the succession in the Crowsnest pass by applying a new formation name, the Allison, to the sandstones which follow the Benton-Niobrara formation, but found no fossils in them. McKenzie, however, reports a few fossils from the Allison, but does not name them. The writer succeeded in finding four faunules in this formation, two of brackish water and two of fresh water type, which together with that of the Benton-Niobrara, define the succession in this locality from the Benton well into Belly River time.

The Dakota formation and the overlying Crowsnest volcanics, the basal members of the Cretaceous, outcrop on the western border of the Blairmore quadrangle, and west of the sheet the Benton-Niobrara and Allison formations follow, dipping to the west. The section is not disturbed by folding or faulting. The measurements and collections described here are confined to the two higher formations of the section. In the section studied, the lower 600 feet and the uppermost 180 feet are concealed, and the intervening (about) 1,920 feet of shale, clay shale, and arenaceous shale has been studied and collected from.

The rocks consist for the most part of shales which are dark and somewhat carbonaceous, with numerous small ironstone concretions. Arenaceous shales are present at some horizons, especially in the lower part. Only a few thin beds of true sandstone occur. The arenaceous beds weather slightly reddish. The shales grade into clay shales and clay. In general it may be said that the lower part is more arenaceous and the upper part of the section more argillaceous. The whole section is somewhat carbonaceous, with plant stems, wood debris, etc. Some of the wood is silicified and at two horizons is attacked by boring pelecypods.

The fauna is a small one and largely fragmental. Most of the specimens are found in concretions. Fossils are more abundant in the upper part, but the majority of the species range through the whole section. They are all marine. On the basis of *Baculites asper* this fauna is referred to the Benton-Niobrara.

The Allison section here described, ranges through 2,180 feet of strata and extends up to a prominent conglomerate horizon, beyond which outcrops are few and the rocks are apparently disturbed by faulting.

The section up to the conglomerate may be summarized as follows: beginning at the base, there are 300 feet of massive sandstone and grey arenaceous shale, with a brackish water *Ostrea* faunule at 170 feet, then 50 feet of grey clay and shale, with four coal beds and a brackish water *Corbula* faunule at 8 feet above the base of this division, followed by 1,830 feet of sandstone and olive green clay and clay shale, which becomes light green at the top. The upper sandstones contain two freshwater faunules, a "sand bottom" and a "clay bottom" assemblage, repeated many times in the section. The former consists of *Unio* and gastropods, inhabitants of the stream channels, and the latter chiefly of gastropods, inhabitants of the ponds, lagoons, back swamps, etc.

Although the fossils have not been determined, the zone of grey clay and coal with the *Corbula* bed and the upper sandstones and clays with the fresh water faunules all appear to be typical of the Belly River. The age of the lower 300 feet of massive sandstone may be equivalent in time to the Eagle, which does not seem to be present here in its normal development.

Section on North Fork of Oldman River.

Collections were also made along the North fork of Oldman river from the border of the Porcupine hills westward across the valley to within about 3 miles of the Livingstone range. Only the strictly Cretaceous part of the section is treated in this preliminary statement, since it illustrates the passage from Benton to Belly River. The Dakota formation and Crowsnest volcanics are absent from this part of the section.

The section begins with the Benton-Niobrara, to which 1,150 feet of dark shale with concretions may be assigned. The base is not known. Fossils like those of the Benton-Niobrara of the Crowsnest pass are abundant in the lower 600 feet and include *Baculites asper* and *Inoceramus.*

The Benton fauna continues through the succeeding 550 feet of arenaceous shale, the fossils, which are rare, including an occasional *Ostrea.* At 1,200 feet a different fauna appears in a sandstone zone, but it is poorly developed. The succeeding 300 feet of dark shale with a few sandstone beds are barren of fossils.

These are followed directly by sandstones and olive green shales and clays, lithologically like the upper part of the Allison formation in the Crowsnest pass and containing a similar fresh water fauna. No *Corbula* beds have been found here. The massive sandstone of the lower 300 feet of the Allison is also lacking here. As in the Crowsnest pass, the marine Claggett is apparently also wanting, and the fresh water sandstones and clays are probably of Belly River age. The upper part of the latter series is not exposed here. Farther east, however, near the Bull camp of the Waldron ranch, light green, clay-shales and sandstones directly underlie marine dark shales holding *Baculites ovalis*, etc., which are probably of Bearpaw age. The clay-shales and sandstones are probably upper Belly River, and it may be that the light green character of the clay shales is a lithogical peculiarity of the uppermost Belly River contrasted with the usual olive green.

In comparing the two sections, it may be said that they are similar in the absence of a typical marine development of the Claggett. In both localities it may be that the Belly River sandstones extend farther down than usual, to include a part or all of Claggett time. On the North fork, however, the Claggett may be represented by the barren upper part of the dark shales, which below carry the Benton-Niobrara fauna. On the Crowsnest river all of the exposed lower dark shales carry the Benton fauna and only about 180 feet are concealed.

The evidence of the two sections studied suggests that the early Montana sea did not extend into parts of southwestern Alberta. The later invasion of the Montanian sea, however, is recorded by a comparatively thick series of marine shales (Bearpaw). It is not improbable that in a large part of the southwestern Alberta region the late Montanian (Bearpaw) overlap extended farther west into the mountains than did the earlier (Claggett).

We thus have three developments of the Montana group, the Pierre-Fox Hills (Hayden) of the east, the Eagle-Claggett-Judith River (Belly River)-Bearpaw (Stanton and Hatcher) of the western part of the sea, and the Eagle(?)-Judith River (Belly River)-Bearpaw of the extreme western border of the interior Cretaceous basin.

WOOD MOUNTAIN COAL AREA, SASKATCHEWAN.

(Bruce Rose.)

INTRODUCTION.

During the field season of 1914 the examination of the coal measures and associated formations of southern Saskatchewan, begun in 1913 in the Willowbunch area, was extended westward, and an area comprised of tps. 1 to 7 in ranges 1 to 13 W. 3rd mer., was investigated. The Wood Mountain sheet (sectional map, No. 18, scale 3 miles to 1 inch) of the Topographic Survey Branch, Department of the Interior, was used as a base map for the map of coal outcrops which has been prepared to accompany this report.

A period of two and one-half months, from the middle of May to the end of July, was occupied in field work, during which time R. C. Hargrave acted as assistant.

The season's work shows that the coal-bearing formation extends westward across the area examined, but is not generally distributed as in the Willowbunch area. In the Wood Mountain area it is confined to a plateau-belt which has the greatest width at the east side of the sheet, becoming narrower to the westward and from ranges 6 to 13 occupying a belt which is in few places more than 5 miles wide. This belt of coal-bearing formation is known to be entirely cut off a short distance to the west but reappears again in the Cypress hills. The area within which coal can be found is outlined on the map.

The coal is a lignite of good quality and is similar to the lignites of the Willowbunch area and the Souris field to the east. It is abundant in quantity but is, of course, confined to the narrowing belt in which the coal formation occurs.

The clays associated with the coal, like those of the Willowbunch area, differ widely in character. While a few of the beds are poor, there is much clay suitable for ordinary brick, and for stoneware, and some that is very refractory. The portion of the area beyond the limits of the coal-bearing formation, is occupied by dark grey shales and clay shales which are as a rule, unsuitable for the manufacture of common brick.

GENERAL CHARACTER OF DISTRICT.

The topography, climate, and agricultural conditions are like those of the Willowbunch area described in the Summary Report of the Survey for 1913.

The Wood Mountain area lies in the Great Plains province, a plain developed on nearly flat-lying strata, where, over great areas the slope of the surface coincides with the dip of the underlying beds, though considered as a whole, it cuts the strata at small angles. The plain was formed in pre-Glacial times and since then the surface has been considerably modified by glacial scour and deposition. It is in general a region of rolling prairie interrupted by ridges and valleys.

The plain is developed largely on Cretaceous rocks, the Tertiary rocks that once overlaid it having been eroded during the base-levelling process. However, in the Wood Mountain area, a remnant of Tertiary deposits has escaped denudation and in these rocks the coal is found. The boundary between the Tertiary and surrounding Cretaceous rocks is marked by an abrupt rise of from 200 to 300 feet, so that the latter sediments stand as a plateau superposed on the Great Plains. This is the Wood Mountain plateau, the westward extension of the Willowbunch coal area. From ranges 6 to 13, it is merely a ridge which is in few places more than 5 miles wide. The

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GEOLOGICAL SURVEY

ECONOMIC GEOLOGY

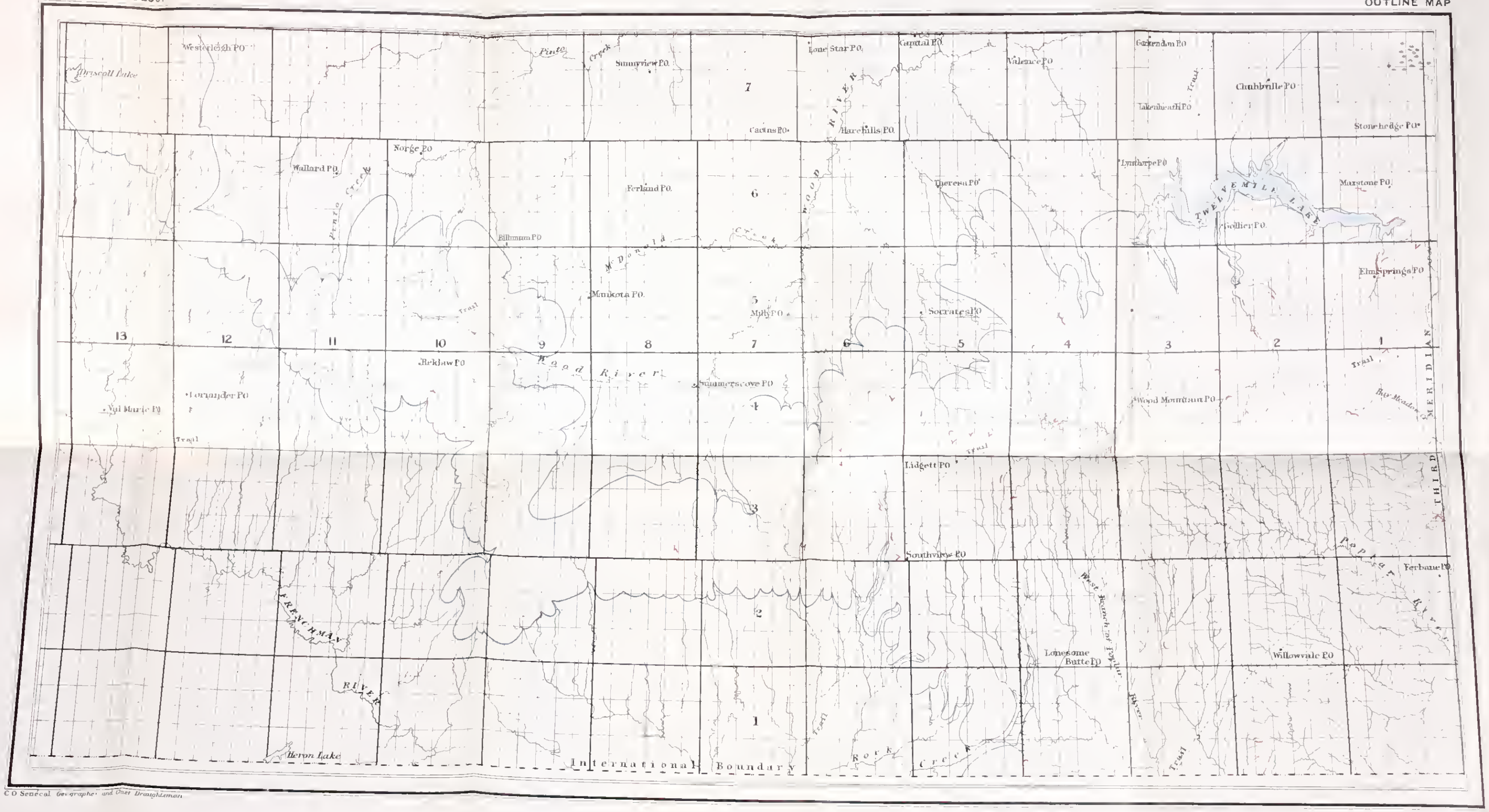
OUTLINE MAP

LEGEND

Coal seams (actual outcrops)

Coal seams (inferred outcrops)

Boundary of possible coal area



C. O. Senécal, Geographer and Chief Draughtsman

MAP 117A
Issued 1915

WOOD MOUNTAIN COAL AREA, SASKATCHEWAN.

Scale of Miles
1 0 2 4 6 8 10

To accompany Summary Report by B. Rose, 1914 boundary of the coal-bearing rocks, is then the boundary of the plateau and the boundary between the Cretaceous and Tertiary as well. The surface of the plateau is very irregular and is channelled in all directions by deep and wide coulées. A local area of bad lands is developed along Rocky creek in tp. 1, ranges 4 and 5, W. 3rd mer.

The climate is that of the open, treeless prairie, a typical steppe climate. It is characterized by hot summers, cold winters, high winds, and a meagre precipitation. The region forms a good grazing country; the vegetation consists mostly of grasses which grow abundantly during the wet spring season and cure to a natural hay during the late summer. Trees grow only in the protected hollows of the larger coulées and along the edges of the plateau. The best agricultural land is now taken by homesteaders.

The Weyburn-Lethbridge branch of the Canadian Pacific railway cuts across township 8 just to the north of the map-area and offers the only means of communication by rail. However, since the broken plateau country, and the plains to the south of it, are best suited for grazing, close railway connexion is not necessary.

GENERAL GEOLOGY.

Table of Formation.

Quaternary	Pleistocene and Recent	Superficial deposits.
Tertiary	Eocene (?)	Fort Union formation.
Tertiary (?)	Eocene (?)	Lance formation.
Cretaceous	Upper Cretaceous	Fox Hills sandstone. Pierre shale.

The Cretaceous and Tertiary rocks of the Wood Mountain area are a conformable series of flat-lying shales, clay-shales, clays, sands, sandstones, and lignites. The lignites are confined to the upper members of the series. The Cretaceous-Tertiary boundary is tentatively placed at the top of the Fox Hills sandstone following the usage of the United States Geological Survey in the region south of the boundary. The old name Laramie, as used by the Geological Survey of Canada is replaced by the names, Lance formation and Fort Union formation for this area.

Pierre Shale.—The Pierre shale occupies the plains to the north and south of Wood Mountain plateau. The formation consists of dark-grey, friable shales or clay-shales. The fossils indicate that it is of marine origin.

Fox Hills Sandstone.—The Fox Hills sandstone outcrops at numerous points along the edge of the Wood Mountain plateau. Its outcrop corresponds with the limiting line of the coal formations. It is fine-grained, friable, sandstone or unconsolidated sand, yellowish in colour, and containing a marine fauna. Its thickness, where observed, is in no case more than 75 feet.

Lance Formation.—The name Lance formation has been adopted for the non-marine dinosaur-bearing formation overlying the Fox Hills sandstone. It consists, as a rule, of sombre-coloured clays and sands with a few beds of lignite and carbonaceous shale and bands of clay-ironstone nodules. The beds where exposed, have a tendency to weather to a bad-land topography. This formation lies near the Cretaceous-Tertiary boundary and there has long been controversy concerning the exact geological age of its beds. It holds a typical Fort Union fossil flora and lies conformably under that formation so that paleobotanists claim for it an Eocene age; but it contains dinosaurian fossils of pronounced Mesozoic types and so vertebrate paleontologists claim that it is Cretaceous in age. In the Wood Mountain area the rocks overlying the Fox Hills sandstone consist for the first 150 feet of feebly coherent greyish and white clays, silts, and sands with occasional beds of carbonaceous shales and lignites. In the vicinity of Rocky creek, where the clays preponderate the surface has weathered to a bad land topography. The beds here contain dinosaurian remains. It seems probable, therefore, that these beds represent the Lance formation, and that the lower 150 feet of the lignite-bearing beds throughout this area may be referred to that formation. No attempt was made to map these beds separately from the overlying Fort Union beds. The evidence found in this area bearing on the Cretaceous-Tertiary boundary problem indicates that there was a transition period during which sedimentation proceeded quietly and more or less continuously from the marine Cretaceous of the Fox Hills sandstone, through the freshwater Lance formation to the typical freshwater Eocene of the Fort Union formation.

Fort Union Formation.—The Fort Union formation occupies the Wood Mountain plateau. It is a continuation or upper division of the rocks described under the Lance formation. Clays, clay-shales, sands, and lignites with a few beds of hard sandstone make up the mass of the formation. In colour the beds range from yellowish-grey through drab and grey to almost white. It is in this division that the workable coal seams occur. Of the seams examined one is 11 feet 6 inches thick. It outcrops in sec. 16, tp. 4, range 4, W. 3rd mer. Seams varying in thickness from 4 to 7 feet are worked for local use at several places and smaller seams are of common occurrence. Freshwater fossil plants of Eocene age are found throughout the formation. The total thickness of this division is approximately 700 feet.

Superficial Deposits.—Gravels, sands, and boulder clays mantle the surface everywhere except on the steep sides of coulées or stream valleys. They are of morainic origin or are outwash deposits from the continental glacier. Recent deposits are few and are so small as to be almost negligible, consisting mainly of a slight rearrangement of surface material, the silting up of stream courses, and the filling in of sloughs with vegetable matter and wind-blown material.

ECONOMIC GEOLOGY.

Coal.

Samples for analysis were collected wherever fresh exposures could be obtained across a seam. The analyses are very similar to those published for the Willowbunch area in the Summary Report for 1913, except that the percentage of moisture in these samples is larger, owing to less thorough drying before analysing. The coal is a lignite of good quality.

Analyses of Coals.

No.	Locality west of 3rd meridian.			Thickness of seam.	Moisture.	Volatile matter.	Fixed carbon.	Ash.
	Sec.	Tp.	Range.					
1	17	4	1	5′ 0″	12·9	40·9	36·8	9·4
2	13	5	1	2′ 0″	12·8	35·9	34·1	17·2
3	21	6	1	6′ 6″	13·1	35·9	31·6	16·4
4	8	1	2	5′ 0″	13·8	38·3	37·3	10·6
5	1	6	2	2′ 0″	12·7	41·3	32·6	13·4
6	10	5	4	4′ 6″	12·0	33·6	29·2	25·2
7	24	4	6	6′ 0″	13·5	36·9	35·8	13·8

Many of the best coal occurrences could not be sampled because of the caved condition of the pits. It is the custom of the farmers to strip the overburden of clay and sand and dig a year's supply in the autumn season; the pits are then abandoned for the rest of the year and the overburden slumps and covers the exposed surface of the coal. The accompanying map, however, shows the location of all known outcrops.

Clays.

A preliminary examination of the clay samples collected shows them to be very like the samples collected in the Willowbunch area in 1913. The dark grey clay-shales, from the Pierre formation, are not well adapted for brick-making as they are stiff and sticky in the wet state, and dry slowly with cracking, warping, and excessive shrinkage. The yellow clays of the Fort Union formation make good ordinary bricks, and the white clays are high grade clays suitable for the manufacture of pottery, stoneware, or sewerpipe.

AMISK LAKE DISTRICT, NORTHERN SASKATCHEWAN AND MANITOBA.

(*E. L. Bruce.*)

Late in the summer of 1913 gold was discovered at Amisk (Beaver) lake in northern Saskatchewan, just west of the provincial boundary, and a number of claims were staked during the following winter. A geological reconnaissance was undertaken with the object of determining the relations of the deposits, their probable importance, and the extent of the formations in which they occur.

The prospects being developed at Amisk lake and in the country around the lake were first examined in some detail. Later a reconnaissance east to the Hudson Bay railway was made, the chief waterways being traversed. East of the Cranberry lakes, the lateness of the season prevented anything but the mapping of the main canoe route, the Grass river, and but little work was done inland in that section.

Thanks are due those in charge of the Prince Albert claims who gave every facility for the examination of the deposit and especially to Mr. Mosher and Mr. Creighton, from whom much information about the district was obtained. The writer also wishes to acknowledge gratefully the assistance rendered by Mr. Hackett, Mr. Woosey, and many others during the season. J. B. Stitt, H. A. McNally, and L. E. Gordon acted efficiently as field assistants.

The rocks of this area consist of a complex of Pre-Cambrian rocks made up of greenstones and schists of both igneous and sedimentary origin, along with small masses of conglomeratic rocks. These are closely folded. They are intruded by granitic rocks, some of which are distinctly foliated gneisses, while others are very fresh massive granites. Overlying these dominantly igneous rocks and separated from them by a great unconformity are magnesian limestones of late Ordovician age. Farther to the south, these are in turn covered by Silurian limestones. In the western part of the district glacial deposits are almost absent, but peat fills the narrow valleys between rock ridges. In the eastern section a thick mantle of fine lacustrine clays covers the consolidated formations.

The most important members of the Pre-Cambrian complex are the greenstones and schists since in them occur the gold-bearing veins. They are well developed about the north end of Amisk lake and extend eastward with some interruptions as far as Lake Wekusko, with a width north and south up to 25 miles. The massive greenstones often show marked pillow structure. The schists are green, chloritic and grey, sericitic rocks. Some of them are plainly derived from greenstones, but many may have other origins. The usual strike is northerly with steep dips to the westward; but the bands are in many places contorted and have varying strikes and dips. Associated with the greenstones and schists are minor amounts of felsitic, amygdaloidal, and autoclastic rocks.

Crossing the Grass river below Lake Wekusko are narrow belts of a greyish weathering, dark, granular rock with marked foliation. Its chief constituents are feldspar and biotite, but some bands carry conspicuous amounts of garnet and staurolite, the crystals of the latter being often an inch or more in length. In strike and dip it parallels schists like those just described, but apparently represents a sedimentary series.

A clearly sedimentary rock occurs as small infolded lenses in the massive greenstones and dervied schists. This is largely conglomeratic with disk-shaped pebbles of greenstone, some felsitic rocks, quartz, and often jasper as the most conspicuous fragments. It is strongly schistose, paralleling the strike and dip of the enclosing older schists. Included as small lenses in the conglomerate and apparently part of the same series, is a deep green, schistose rock, showing no pebbles. The only area of this conglomerate of any size lies northeast of Amisk lake with two narrow bands extending from it to the lake shore.

These strongly folded and highly altered rocks are invaded by granitic rocks which are both gneissoid and massive in character. North of Amisk and Athapapuskow lakes, the greenstones and schists are cut off by a distinctly gneissoid granite, light grey to light red in colour and very fresh in appearance. In many places it contains numerous small, deep red garnets. East of Wekusko lake and developed typically on the shores of Setting and Kiski lakes and along the Hudson Bay railway, is a strikingly-banded, black and white gneiss which on the surface weathers to black and red bands. Many of the white bands seem pegmatitic in character and there is some doubt as to whether it is an original rock unit or represents a hybrid rock due to the injection effect of a massive light red granite, of which masses occur, intruding an older schist. This massive light red granite is found as masses and tongues of various sizes in all parts of the belt from Amisk lake eastward. It is light pink and massive and is probably the parent mass to which the pegmatites common in the eastern part belong.

At two places in this area gold in visible quantities has been discovered. The first gold was found on the Prince Albert claim in August, 1913, the other discovery was made near Wekusko lake in the summer of 1914. On the former claim a shaft is now (October, 1914) down 70 feet and a compressor plant stamp and concentrating mill will be installed as soon as the lakes freeze. On the latter considerable stripping has been done but no sinking (October, 1914).

The vein being worked at the Prince Albert lies in a schistose zone 200 feet wide, in massive greenstone. It strikes north and south and dips 60 degrees west, paralleling the structure of the country rock. It is somewhat lenticular, varying from 2 to 9 feet in width. A smaller vein 20 inches in width, lies a few feet to the east and having a flatter dip joins the main vein in depth. Native gold occurs, usually, along irregular, greenish lines or on slip planes coated with a yellowish micaceous mineral, but also sometimes in apparently solid quartz. Altered wall rock is also said to carry values; but, owing to the parallelism of the enclosing schist alteration has not proceeded far from the main fissure. Other metallic minerals are present only in small amounts. The most abundant of these is arsenopyrite, usually as tiny crystals in the wall rock, less commonly as a massive granular variety in the gangue. Pyrite and a little chalcopyrite, molybdenite, galena, and stibnite are present. Surface alteration has produced traces of copper carbonate and some iron stain. The quartz varies in colour from milky through bluish and pinkish to a mottled brown. The Monarch vein, on a small island east of the Prince Albert has not been developed but seems to have a considerable width. It strikes N. 80° W. A small vein on the east side of the big point in Wekusko lake, occurs near the contact of green schists and a dark grey porphyritic rock with feldspar phenocrysts of large size, intrusive into the schists. All other gold-bearing veins seen, occur in greenstone or schist. They are usually, however, near intrusions of the massive granitic rocks and for this reason and from the apparent nature of the granite it is believed that the ore may be genetically related to it.

PEMBINA MOUNTAIN, MANITOBA.

(A. MacLean.)

The work for the field season of 1914 consisted for the most part in an examination of the Pembina Mountain region in the neighbourhood of the International Boundary. In addition one week was spent at the beginning of the season in the Gilbert Plains district examining Cretaceous exposures in the gap between the Riding and Duck mountains. During the period spent in the Pembina Mountain area able assistance was rendered by C. J. Moir, student of the University of Manitoba.

In the Gilbert Plains region the exposures are in the valleys of the Wilson and Valley rivers some distance to the east of the town. In the immediate vicinity of the town the Cretaceous is concealed under a heavy deposit of drift including mantle rock-glacial till and post-glacial alluvials. The lowest rock well exposed is a 3-foot layer of limestone which is probably the same bed as that placed by Tyrrell at the top of the Niobrara in the Vermilion well[1]. This band is also reached by drillers at Gilbert Plains at about 140 feet below the ground surface at the town. Above this limestone in the Valley River exposures is a dark carbonaceous shale designated by Tyrrell as the Millwood series of the Pierre.

In the Pembina Mountain region a limestone very similar in thickness and character of fossils to that above mentioned is found at a depth of 28 or 55 feet below the general level of the town of Morden. Its position also agrees very well with the conjecture that it is an extension of the Niobrara bed.

The following table is intended to include the rocks in the eastern part of Pembina mountain as they are found in section in the highest front of the mountain or as they are exposed in succession from Morden westwards.

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[1] Report on N.W. Manitoba (Part E Annual Report, G.S.C., Vol. V, p. 86).

No.	Description of rock.	Approximate thickness in feet.	Locality.
11	Lacustrine and beach deposits of Lake Agassiz..........................	....	East of a contour line drawn approximately from sec. 23, tp. 1, range 5 to middle of sec. 10, tp. 3, range 6.
10	Glacial till..............................	... .	Over the whole field except where covered by the above.
9	Hard, steel-grey shale, breaking into flakes and splinters and weathering to dark rusty grey and iron-stained on joint planes and bedding planes	200+	West of Morden first exposure at N.W. corner tp. 19, sec. 2, range 6. On Pembina escarpment in highest parts and along the valley from the International Boundary to the west of the field.
8	Heavy, waxy, tenacious clay, probably consisting largely of colloidal material, very similar to bentonite. About.......	50	In Dead Horse valley forming subdued bad lands topography in sec. 20, tp. 2, range 6, east side of Pembina escarpment in tp. 1, range 5. In Pembina valley from International Boundary to E. ½ sec. 23, tp. 2, range 9.
7	Chocolate-brown shale, passing up into dense black carbonaceous shale, with earthy fracture. In the upper 30 feet this alternates with beds of white, earthy clay.	80	In Dead Horse valley on right bank in W. ½ sec. 21, tp. 2, range 6. In Pembina mountain and valley exposures as in No. 8.
6	"Chalk," bluish grey and fairly consistent in texture. Weathers to yellow or buff surface and breaks in columnar fragments.	25	Dead Horse valley W. ½ sec. 27, tp. 2, range 6. East face Pembina mountain in tp. 1, range 5. Pembina valley from International Boundary to sec. 23, tp. 1, range 8.
5	Calcareous clay, fairly well bedded, bluish grey; weathers to a grey granular surface. About.....	25	Valley of Dead Horse creek at N.E. ¼ sec. 34, tp. 2, range 6. Pembina valley from International Boundary to W. side tp. 1, range 7.
4	Calcareous shale or marl forming projecting beds on exposure slopes. About.	8	In Pembina valley as above (for 5).
3	Grey carbonaceous and calcareous shale, similar to No. 5. About................	80	Exposures as for 4 and 5 above.
2	Black carbonaceous shale, streaked with yellow clay and containing crystals of selenite. Calcareous concretions and septaria are scattered in bands and irregularly through it. About.........	200	Along the lower part of the Dead Horse creek near Morden. In the Pembina valley on the right bank of the river near the International Boundary. (S.W. corner of S.E. ¼ of sec. 4, tp. 1, range 6).
1	Hard, compact, blue limestone, very fossiliferous	3	In wells, at Morden at a depth generally of 55 feet in one well 28 feet below the surface.

All the rocks here mentioned are apparently flat, but have a slight dip of from 4 to 10 feet to the mile in a southwesterly or west-southwesterly direction. This dip is fairly uniform over large areas but it is not to be assumed that the surfaces of the beds form absolute planes, with no flexuring. There are undoubtedly minor flexures, probably in the form of monoclinal folds which in places bring the beds to a higher level than that of a plane of the character mentioned above. One such fold is indicated in the limestone at Morden and another by the position of the "Black and White" beds in the Pembina valley south of Manitou. At the last named place prospecting for gas has met with some success.

The economic interests of the region from a geological point of view centre about the possibilities of the occurrence of oil and gas and in the use of the shale for the manufacture of brick and cement.

Practically all the members of the formation with the exception of Nos. 6, 8, 9, 10, and 11 are more or less impregnated with oil. They give off a strong petroleum odour on being warmed and may yield oil on distillation. This impregnation continues even below the beds above mentioned and is met with down as low as the top of the Dakota sandstone. In digging wells for water small pockets of gas are often struck, while south of Manitou it is reported that a strong flow of gas of good quality was struck. From the wide distribution of the oil throughout the shales it seems probable that the oil and gas found in these members originated in the beds themselves rather than in the beds below them. This feature combined with the attitude of the beds and the absence of any porous member in a position suitable for the collection and retention of the oil makes petroleum prospecting a hazardous venture. Oil doubtless has been present in these beds and the heavier parts still remain in the shale in quantities that in the aggregate are enormous. These constituents are, however, so effectively retained that they can be extracted and recovered only by distillation. Should oil ever be found in any quantity with a good flow it would probably be the lighter representative of that at present in the shale. The gas, where it occurs, has a strong benzine odour and seems fairly pure and free from sulphur.

A number of the shales have been used for the manufacture of brick and one type of shale for the manufacture of cement. In view of the success that has already attended these attempts further success might be expected to result from a more widespread development of the industry.

Shale similar to No. 2 of the section given, and in all probability the same member, has been used at the Mayo brick plant near Walhalla in North Dakota, while the shale designated No. 3 is at present successfully used by the Leary Brick Company, and that called No. 5 by the Carmen Brick and Tile Company. The intervening member No. 4 is used at Babcock for the manufacture of cement. The "Chalk" so far as known at present has not entered into use in any of the industries. Pending an analysis of the material it is impossible to say whether or not it would be of any value in cement manufacture. The highest beds of the Cretaceous in this district are the hard indurated shales designated No. 9—the hard Odanah of Tyrrell. These have been used as brick-making material at LaRivière.

So far as present information indicates there is very little lateral variation in the character of the various beds in the section, so that a well-proved success in the utilization of the material in any one of the beds at any point would seem to warrant development work at other points in the field where the given bed is exposed.

NOTES ON THE CORES OF WINNIPEG WELLS, MANITOBA.

(*F. H. McLearn.*)

The wells of the city of Winnipeg extend in a line some 12 miles north from the city limits, on the prairie. The most remote is 3½ miles east of Stony mountain. Since core-drills were used, the core sections are available for study. Through the courtesy of Mr. W. P. Brereton, city engineer, and Mr. A. B. Neilson, in charge of drilling operations, it has been possible to study the sections and make collections from them. No examination of the fossils has been made and the following notes are based on field observations alone.

The Prairie.—The prairie surface here is almost without relief and a large part of it has practically no drainage. In the 8 miles studied, a maximum difference in elevation of 12 feet is recorded.

Rock Surface.—The core sections show that the rock surface lies at a depth of from 25 to 60 feet below the prairie level, that it has about four times the relief of the prairie and slopes to the south at a low angle. A rich black clay soil immediately underlies the prairie surface and is followed by a few feet of light yellowish clay and finally by a bluish clay. Between the blue clay and rock surface is from 2 to 25 feet of gravel and sand.

The Core Sections.—All the strata in the cores are practically flat lying. To a depth of from 155 to 180 feet, the section consists of cream coloured, massive and granular limestone with some cream coloured argillaceous limestone. The remaining 20 to 45 feet of the 200-foot holes consists of massive light mottled limestone. Below 200 feet the predominant rock is a massive dark mottled limestone, which is still present at a depth of 400 feet.

Contact of the Stony Mountain Formation and the Trenton.—Fossils are fairly abundant to a depth of 200 feet. The fauna contains *Rhynchotrema capax*, *Byssonychia radiata*, etc., and is apparently that of the Stony Mountain formation, and Richmond in time. The dark mottled limestone below 200 feet contains very few fossils. About three specimens of large *Maclurea* have been found and also large *Receptaculites* very much like *R. oweni*. This lower rock is probably the upper portion of the Trenton (Galena) found to the east at East Selkirk, Lower Fort Garry, and elsewhere, by Dowling. The core sections apparently show that the contact between the Stony Mountain formation and the Trenton formation lies about 200 feet below the surface here.

GYPSUM AND BRINES IN MANITOBA.

(*R. C. Wallace.*)

INTRODUCTION.

Field work on the gypsum deposits in Manitoba, and on the salt waters which might possibly be connected with these deposits, was carried to completion during the season of 1914. As the brines occur over an area which extends from the north end of Lake Winnipegosis to Grand Forks in North Dakota—a distance of almost 400 miles, and as the width of the belt characterized by gypsum outcrop and salt spring is about 50 miles, it was deemed advisable, while endeavouring to cover the whole field, to restrict more detailed investigation to limited, typical localities. Access to the more northerly part of the field is provided by way of Lake Manitoba and Lake Winnipegosis, and by the two parallel branches of the Canadian Northern railway, skirting the lake system on either side. The least accessible area lies between Lake Winnipegosis and the northern part of Lake Winnipeg, where the presence of extensive swamps, stretching in a direction parallel to the lake system, and separated by comparatively narrow ridges, renders exploration a matter of difficulty. The southern part of the field is well settled, and is provided with a fairly complete network of railways.

Historically considered, the salt springs have occupied a much more prominent place than the gypsum deposits. Records show that in the early years of last century a salt industry was carried on, the salt having been obtained from the brines by the most primitive methods of evaporation. The industry flourished until 1876, and practically all the salt used at the Hudson's Bay Company's posts in the district, and by the early settlers, was obtained from the springs on the west side of Lake Winnipegosis. With the advent of the railway, however, it was found impossible to compete in open market with the salt from Ontario, and to-day practically no salt is obtained from the brines in the province. Gypsum was not recorded until 1889, when Tyrrell reported on the gypsum and anhydrite deposits north of Lake St. Martin. Since 1901, when production started, there has been a steady increase in the amount of the gypsum obtained from the Manitoba quarries. At the present time the production is exceeded only by that of Nova Scotia among the provinces of Canada.

Acknowledgment is here made of the many courtesies extended to the writer by the officials of the Manitoba Gypsum Company and the Dominion Gypsum Company. Thanks are especially due to Mr. J. D. McArthur for the records and accurate information freely placed at our disposal. M. W. Cooke acted efficiently as field assistant.

TOPOGRAPHY.

The topography of the country lying between the west shore of Lake Winnipeg and the foot of the Manitoba escarpment shows little variety. The present topographical features are due almost wholly to the passage of the ice and its subsequent withdrawal, and to the beach formations at the successive stages in the lowering of Lake Agassiz. The broad features depicted on a topographical map are reproduced on a smaller scale in any part of the whole area. The map shows three parallel lines of depression (1) Lake Winnipeg, (2) Lake Manitoba, Lake Winnipegosis, Cedar lake, and Moose lake, (3) Big Grassy swamp, Lake Dauphin, Swan lake, and Red Deer lake. These lake systems extend in a direction 25 degrees west of north, and represent shallow parallel grooves drawn lengthwise on a surface which declines gradually towards the east from an elevation of 900 feet to 710 feet above sea-level. In miniature, a similar topography is seen throughout this part of the field. Between Lake Winnipeg and Lake Manitoba the narrow lakes and swampy depressions are rapidly drying up, and are being replaced by hay meadows. North of the Dauphin river, however, the ridges are low and the swamps deep. The ridges are composed of morainic boulders and till, unassorted by water action. Occasionally old beach formations follow the same general direction, but their course is usually more irregular. The strike of the underlying rock is also about 25 degrees west of north, and a few of the ridges are due, not to accumulations of morainic material on the rock floor, but to elevations of the rock surface parallel to the line of strike.

Where gypsum occurs at the surface, north of Lake St. Martin, there is less uniformity in the topographical features. The ridges are sharper, somewhat more irregular in direction, and the valleys are completely closed. The ridges are pitted with depressions which have the form of inverted cones with wide angles, and many of them are 15 to 20 feet deep. Some of these pit-shaped depressions, and practically all the valleys, hold stagnant water. The relief is nowhere greater than 50 feet, but the topography is—within these limits—extremely rugged. Two influences in particular have moulded the topography of the gypsum country—chemical erosion, and internal expansion due to the transformation of anhydrite into gypsum.

The topographical character of the country west of Lake Winnipegosis has not been appreciably modified by the salt springs, though the salt spring areas are strikingly prominent features of the landscape. They are bare flats, strewn with boulders, which have been subjected to intense chemical erosion. They occur on sloping ground, or on level flats at the foot of slight elevations, and while generally in close proximity to lake or river, are not infrequently found far in the forest. The precipitation which has taken place from the brines is nowhere sufficiently great to have produced distinctive topographical features.

The drainage system is at the early stage characteristic of a youthful topography. In the central part of the country between Lake Winnipeg and Lakes Manitoba and Winnipegosis, the surface drainage follows no definite channels. The stagnant water of the swamps is gradually disappearing, mainly owing to evaporation and seepage. Wherever impervious till does not cover the Silurian limestone, underground drainage is extensive. This is particularly the case from Shoal lake northwards to the headwaters of the Fisher river, and the limestone is here honeycombed with caverns and swallow holes.

AGRICULTURAL RESOURCES, TIMBER AND GAME.

During the last four years there has been a steady flow of settlers into the country between the lakes, though only to a limited extent into the part lying north of Dauphin river. The richest district from the agricultural standpoint is that drained by Fisher river. The soil is a well drained, deep, black loam. This area was thickly settled when the railway was still 40 miles away. The country generally, however, is better adapted to cattle raising than to wheat farming. The morainic ridges are unsuitable for cultivation. On the stone ridges the soil is too shallow. Owing to the gradual desiccation of the swamps, on the other hand, the hay lands are increasing and will ultimately prove valuable for the raising of crops. From the south end of the lakes to the International Boundary line, the soil has long been cultivated, and is the most important asset of the province.

The timber resources are limited. Between Sleeve lake and Fisher river there is some good spruce, and medium-sized tamarack. Good spruce is also found east of Waterhen lake, east of Swan lake, and along the more northerly shores of Lake Winnipegosis. Elm and poplar reach considerable dimensions on the banks of Swan river, immediately west of Swan lake. Cedar is only found north of Lake Winnipegosis.

In the more southerly localities, on both sides of Lake Manitoba, scrub oak is plentiful; but like the poplar, which is everywhere the prevailing tree, it seldom reaches merchantable size. Lumbering oprations are now confined chiefly to the north shores of Lake Winnipegosis, and to the upper reaches of Red Deer river.

Moose, caribou, and elk are plentiful on both sides of Lake Manitoba and of Lake Winnipegosis. Except in the most northerly areas, the musk-rat is the only fur-bearing animal found in numbers. On the Warpath river, from Waterhen lake northwards to the north end of Lake Winnipegosis, and on Red Deer and Overflowing rivers, bears, timber wolves, mink, and otter are abundant, and lynx are occasionally trapped.

In the winter months, fishing is prosecuted on Lake Winnipegosis and Lake Manitoba; while, during six weeks in the autumn, restricted areas on Lake Winnipegosis are fished. Whitefish, pickerel, and jackfish are abundant in the larger lakes, and are also caught in many of the smaller lakes. Fishing and trapping are the main occupations of the few settlers on the shores of Lake Winnipegosis.

GENERAL GEOLOGY.

The main gypsum deposits are interbedded with Silurian dolomites, while the salt water horizon reaches the surface in Devonian limestones. The stratigraphy of the Silurian and Devonian formations was considered from the standpoint of the physical conditions which gave rise to the deposition of gypsum, and of the general relationship of the salt water horizon to Devonian or other strata.

Silurian.

The Silurian exposures were examined from the north end of Lake Winnipegosis southward throughout the province. The older designation of the beds—Niagaran—as applied by Tyrrell, has been recently discarded by Kindle on palæontological grounds, and the local term Stonewall series has been substituted. The subdivisions of the Stonewall series are:—

(c) *Leperditia hisingeri* zone.
(b) Gypsum beds.
(a) *Conchidium decussatum* zone.

The outcrops are isolated, and it is consequently somewhat difficult, with the lithological and palæontological evidence available, to formulate a detailed statement of the stratigraphy. Perhaps the most complete section exposed south of the Saskatchewan river is that seen along, or in the vicinity of, the Inwood branch of the Canadian Northern railway from Fisher Branch northwards to Hodgson. There is here a gradual rise in elevation from north to south, and there are fairly frequent outcrops, extending in horizon from the Stony Mountain shales to a fine-grained lithographic dolomite in the *Leperditia hisingeri* zone. Another section is obtained from the quarries at Stony Mountain, Stonewall, and Gunton, and from various surface exposures north of Inwood. *Conchidium decussatum*, from which the zone has been named, appears to be rare in this latter section—Tyrrell having found the only recorded specimen at Stonewall.

During the deposition of the dolomites of the *Conchidium decussatum* zone, shallow-water conditions prevailed. The ripple marked, highly arenaceous limestone at the base of the formation, represents an in-shore phase. The sea deepened, and red clay was laid down, followed by a dolomite which contains few traces of fossils. After a second shallowing, deeper water conditions ensued, and during this—the latest—stage, marine life flourished, and extensive coral reefs formed on the eastern margin of the sea.

The boundary between the *Conchidium decussatum* zone and the gypsum beds is drawn, in the light of the evidence now collected, southeastwards from the narrows of

Lake St. Martin to a point a few miles south of Fisher Branch, thence southward along a line lying east of Broad Valley and Inwood and west of Stonewall and Winnipeg, thence southeastward across the Red river to the 49th parallel, crossing the line somewhat east of Stuartburn. North of Lake St. Martin the position of line is somewhat doubtful, but may be drawn provisionally from a point 6 miles east of Gypsum lake to "Roche Rouge" on the Saskatchewan river, between Cross lake and the Grand rapids, the line passing east of Pickerel lake.

The deposition of gypsum took place during a period of shallowing and desiccation that succeeded the reef building period. Gypsum was precipitated over a wide area, but topographical conditions controlled the duration of the process of deposition. At the beginning of Palæozoic times, the Pre-Cambrian surface had not reached the advanced stage of peneplanation which it now shows. North of Lake St. Martin and Partridge Crop lake there are several exposures of igneous rocks of Pre-Cambrian age. These exposures represent the tops of hills or a high plateau that rose at least 800 feet above the Pre-Cambrian surface. As a consequence of this topographical feature, on the shallowing of the ocean relic seas were formed, concentration ensued, and the deposition of gypsum lasted for a much longer period here than elsewhere. The red shale at the base of the gypsum deposits may be traced throughout the field. The gypsum itself, which has, including anhydrite, a thickness of over 100 feet in the Gypsumville district, is found in comparatively thin, unimportant beds elsewhere in the province. North of the Gypsumville area no evidence of gypsum has been obtained. The lithological and palæontological character of the rock exposures on the east side of Waterhen lake and Lake Winnipegosis affords the only data for determining the approximate position of the gypsum horizon in the northern area.

After a period of widespread desication, marine shallow-water conditions again prevailed, and a series of dolomites were laid down which represent the highest Silurian zone in Manitoba. These dolomites have been in part chemically precipitated, and certain phases are of lithographic fineness. Elsewhere they contain abundant ostracods, associated with *Strophomena acanthoptera*, and Stromatoporoid beds. Thin beds of chert are also found in close association in the exposures on the east side of Lake Winnipegosis. The brecciated character of the rock, the leaf-like thinness of the beds exhibiting cross-bedding in miniature, and the ferruginous character of the red dolomites which constitute the upper beds, all point to shallow water deposition. At the end of the period, elevation took place, and land conditions prevailed in early Devonian times.

The deposition of gypsum consequently took place within a period when shallow seas and chemical precipitates were the rule rather than the exception. The attitude that gypsum and salt deposits are the result of the reworking of old land surfaces under desert conditions, is being more generally adopted than heretofore; and the investigation was conducted with that standpoint in view. Anhydrite bulks prominently in the deposits, forming the greater part of the lower strata; and the lowest gypsum beds, at least, were also originally beds of anhydrite. The anhydrite is believed to have been originally deposited as such; and continuous deposition of anhydrite cannot be satisfactorily accounted for under the desert hypothesis. The thin film-like layers, the "seasonal rings' under desert conditions, are not found at Gypsumville. Films of impure gypsum are found between heavier layers, 3 to 4 inches thick; but these are difficult to explain otherwise than by precipitation. It is believed that the precipitation took place in closed or partially closed inland seas; that the stratigraphical succession, gypsum—anhydrite—gypsum, represents the mineralogical sequence of deposition under the control of temperature fluctuation; and that precipitation stopped before extensive deposition of chlorides took place. Topographical inequalities are responsible for the differences in duration of deposition in different areas, but precipitation took place in districts so far apart as the Mackenzie basin and the southern boundary of Manitoba.

Devonian.

The Devonian formation in Manitoba was divided by Tyrrell into the three zones:—

Manitoban.
Winnipegosan.
Red Shale (seldom exposed).

Kindle has relegated the red shales to the upper Silurian, and has subdivided the Devonian into:—

(c) Manitoban.
(b) Winnipegosan.
(a) Elm Point.

There is a strikingly close resemblance between the Elm Point and Manitoban limestones. Both have been formed in moderately deep seas, which contained abundant life; and both have been entirely unaffected by magnesian salts. Subsequent structural changes have modified both in similar fashion, causing a peculiar doming which is responsible for the majority of the outcrops; and stylolitic markings are very perfectly developed in both formations. The chief palæontological difference, as reported by Kindle, is that a rather peculiar variety of *Atrypa reticularis,* which is the commonest Devonian fossil in this area, is developed in the Elm Point zone. For this reason the horizon has been named the *Atrypa recticularis* (var. a) zone. Exposures at Steep rock (Lake Manitoba), 4 miles south of Ashern, and 4 miles northeast of Moosehorn, all show the Elm Point limestone resting on the red dolomites of the upper Silurian. The Devonian limestones at the north end of Waterhen lake, and several exposures on Pelican bay and at Graves point, Lake Winnipegosis, are also of Elm Point age. The Manitoban limestones are most extensively developed on the west side of Dawson bay, on Red Deer river, and on Swan lake. They appear immediately below the Dakota sandstone on the south side of Swan lake.

Between the Elm Point limestones and the Manitoban formation, there lies a harsh, porous, magnesian limestone, well developed on the east side of Dawson bay. Palæontologically the Winnipegosis formation is interesting owing to the occurrence of the European species *Stringocephalus burtoni* in its fauna. This fossil was found by Tyrrell in the magnesian limestones which are exposed on the east side of Dawson bay. Some of the exposures on the islands in Toutes Aides bay, Lake Manitoba, furnished abundant specimens of the same fossil, during the present investigation.

In middle and upper Devonian times, deeper water conditions prevailed than during the Silurian period. At the beginning and at the close of the Winnipegosan subperiod, shallowing took place, and red shales underlie and overlie this zone. Within the Manitoban formation also, a bed of red shale occurs, clearly exposed in the Point Wilkins section on the west side of Dawson bay. These red shale bands are, however, unimportant measures within the limestone formations, which almost everywhere carry abundant organic remains. The Winnipegosis limestone, though dolomitized, possesses a much more varied fauna than the Manitoban limestones. Dolomitization has taken place subsequently to consolidation and fossil and rock are now firmly cemented together.

The salt springs are found in or near the outcroppings of limestones of the Manitoban formation. Occasionally they appear at the base of the Manitoban, or even in the upper beds of the Winnipegosan limestones. Usually, however, the brines reach the surface through the upper beds of the Manitoban limestone; as on the Red Deer river and in the Red Deer Lake district, on Swan lake, and in the area west of the south end of Lake Winnipegosis and the north end of Lake Manitoba. Southeast of Swan lake salt springs appear about 150 feet below an outcrop of Dakota sandstone, and probably less than 100 feet below the base of the Dakota formation.

The possibility of the brines being genetically connected with the gypsum beds of the Silurian is negatived by the presence of a freshwater horizon between the gypsum beds and the brines. Wherever beds of *Leperditia hisingeri* dolomite outcrop on the east side of Lake Winnipegosis on Waterhen lake, or on Lake St. Martin, there is an active flow of spring water, giving rise to a peculiar type of beach topography. The low flat beaches are ribbed owing to parallel groovings normal to the lake front. At the head of each grooving a spring is found. The water contains a fairly high percentage of carbonate of lime, which is being abundantly precipitated by the unicellular green alga Glaeocapsa. In Pickerel Creek bay considerable beds of marl are being formed in this way. Apart from this widespread zone of circulation in the upper Silurian, isolated freshwater springs have been found in the Elm Point limestone, at Graves point and elsewhere. As no trace of salt has been obtained in the sulphate waters of the gypsum zone, and as a definite freshwater horizon exists between it and the strata from which the brines issue, one must conclude that there is no genetic relationship between the gypsum and the salt.

A critical examination of a series of analyses, not yet completed, is necessary before a conclusion can be reached as to the origin of the brines. This discussion will be found in the final memoir. The following considerations may here be presented. There are two horizons from which the brine may have been derived—the upper Devonian, from which the waters issue, or the Dakota sandstone, at the base of the Cretaceous formation. As pointed out below, no great thickness of salt bed need be postulated to account for the sodium chloride which has already reached the surface. But evidence has not yet been forthcoming, either from borings or from the numerous exposures, that such salt beds occur in upper Devonian limestones, or that conditions have ever been favourable for the formation of such deposits. The Dakota sandstone is a well-known water-bearing horizon throughout the western plains of North America. In the middle western states the waters from this horizon are sulphate waters, but the chlorine content increases from south to north. The water is under high pressure, and is prevented from escaping upwards by impervious Benton shales. The outcrops on the edge of the eastern escarpment are generally covered by glacial till. The Manitoban limestone affords an easy passage for water under pressure, and it seems probable that the water from the Dakota sandstone penetrates downwards into this limestone, and reaches the surface where the limestone is exposed, or where the coating of clay is sufficiently thin to admit of the passage of water through the fissures in the surficial deposits.

ECONOMIC GEOLOGY.

Gypsum.

For practical purposes, the gypsum deposits of the province may be divided into three areas, all genetically connected, and all representing longer periods of precipitation than has elsewhere taken place. These are the Gypsumville area, the Leifur area, and the southern area in the vicinity of the Dominion City.

(1) In the Gypsumville area, an estimate of the gypsum actually exposed in the district may be taken as approximately 130,000,000 tons. The annual output is between 70,000 and 80,000 tons. The estimate is exclusive of anhydrite, which represents probably 25 per cent of the whole deposits. From the evidence of exploratory drilling, the maximum depth would appear to be 135 feet. A complete section is obtained at the quarry, where the beds dip towards the north. Owing to the very active water circulation when the upper levels of the deposits are penetrated, it is possible to mine profitably only the upper 30 feet of the deposits; while in the valleys between the gypsum ridges, though gypsum undoubtedly exists, it is covered by stagnant water and rendered inoperative.

Several varieties of gypsum occur. The most common is a greyish, finely crystallized rock, in beds 2 to 3 inches thick, separated by thin earthy partings. It is underlaid by anhydrite, and part, at least, of the gypsum is a transformation product of the anhydrite. Several of the lower beds of the quarry consist of an inner core of anhydrite with an outer coating of gypsum on the bedding planes. The upper and lower beds of this variety of gypsum in the quarry section are stained red, owing to a small admixture of clay in the gypsum. Satinspar is found in the upper red gypsum in very thin bands, usually not exceeding an inch in thickness. It has been formed by secondary precipitation in the bedding planes of the gypsum. A single bed of pure white gypsum powder, quite unconsolidated, was also found. This bed is in places 3 feet thick. While of exceptional purity, the material is of small value from the technical standpoint, its extreme plasticity causing trouble during milling operations. In one locality (Elephant hill) beds of selenite occur interstratified with massive gypsum. These beds have probably also been formed by secondary deposition. As very large transparent plates may be obtained, this locality may furnish a somewhat valuable supply of selenite for museum purposes.

Where the anhydrite, in the quarry section, is intimately associated with the gypsum, a quite considerable amount of it is utilized for purposes of plaster, apparently without affecting the quality of the plaster. It occurs independent of gypsum to a depth of 100 feet east of Gypsum lake, and in this occurrence, owing to its hardness and pleasing colour effect, it possesses some value as an inside decorative stone.

(2) For some years exploratory drilling has been carried on in the Leifur district, in order to determine the extent and value of the gypsum beds in that area. Gypsum is found to occur in tp. 20, range 10 W., principally in sections 22, 23, 27, 28, 33, 34. A typical section is somewhat as follows:

Soil	1–3 feet
Yellow clay	7 "
Gypsum and clay	1 foot.
Gypsum	8–10 feet.
Blue clay	1 foot.
Gypsum	1 "
Red clay	9 feet.
Limestone	..

No outcrops of gypsum have been found, but on section 26 the ground is pitted, presumably owing to the underground solution of gypsum. The beds dip southwestwards, and the gypsum is nearest the surface in sections 20 and 16. The total thickness of the gypsum beds is small, and it would be hardly possible to operate successfully in this district, even where the beds are near the surface.

At considerably greater depths, gypsum has also been found in tps. 18 and 19, range 10 W.

(3) In the southern part of the province, gypsum has been discovered by drilling in the vicinity of Dominion City, at Arnaud, St. Elizabeth, and St. Pierre. The depth of the gypsum is variable, ranging from 150 to 200 feet at Arnaud and St. Elizabeth, and from 260 to 380 feet near Dominion City. The sequence of deposition is, however, the same throughout. The underlying rock is a limestone, containing a bed of sand in which a brackish water is tapped. This is overlaid by red shale, above which lies the gypsum. East of Dominion City, a bed of dolomite is found above the gypsum, and is capped by hardpan, while at St. Elizabeth the gypsum lies immediately underneath the glacial deposits.

The thickness of the beds is not more than 30 feet in the borings at St. Elizabeth and Arnaud, but is considerably greater east of Dominion City. The gypsum is separated by layers of red shale into distinct beds, which are very thin near the base of the formation, but increase in thickness upwards. At St. Charles, west of Winnipeg, the same type of formation was found on drilling, a thin gypsum bed resting on red shales at a depth of 40 feet. This would indicate a horizon in Silurian strata, slightly higher than the limestones at Stonewall, and presumably identical with that of the beds at Gypsumville.

SALT WATERS.

Approximately 80 salt spring areas were examined, and measurements of flow and temperature made. The flow of the springs is controlled by the height of the ground water level, and is consequently greatest in the spring and smallest in the late autumn. It was unusually small during the autumn of 1913, and the summer of 1914, two periods of exceptionally pronounced drought. For this reason, the results of the measurement of flow, all of which were made within these periods, are to be considered as much below the average figures. Moreover, while the figures represent the summarized statistics from the areas known to Indians or white settlers, or discovered during the explorations, they are no doubt far from being complete figures and it is perhaps reasonable to assume that they do not include more than three-fourths of the springs which reach the surface of the land areas, while a very considerable volume of water issues directly into the lakes and rivers. The estimated total flow of 400 gallons per minute is, therefore, because of exceptional conditions and incompleteness of data, much below the actual flow, and probably represents not half the average total flow. On the basis of the figures obtained, however, more than 53,000 tons of dissolved salts reach the surface every year, 85 per cent of which is sodium chloride. In other words, at least 27,500 cubic yards of sodium chloride are every year carried to the surface by the springs in Manitoba alone. Estimated on these figures, the sodium chloride that has been leached out since the beginning of last century, when the springs were first operated, would, if taken from an area 200 miles long by 30 miles wide—approximately that covered by the more important springs—represent the extraction of a bed of rocksalt only 0·0035 inches thick. The scanty records available seem to show that the concentration of the brine is decreasing. If allowance be made for this, and for the incompleteness of the data, and the figure obtained be quadrupled, a little more than a fortieth of an inch of rocksalt has been dissolved away from this area since the beginning of last century. It is, therefore, unnecessary to postulate the existence of considerable beds of rocksalt, in discussing the origin of these brines.

The normal percentage of solids in the brines on the west shore of Lake Winnipegosis, where the brines are strongest, is 5·5 to 6·0. They decrease in strength southwards, and the percentage of chlorine in the total solids is lower, and that of the carbonate and sulphate radicals higher, than in the more northerly brines. Such percentages are too low to ensure profitable exploitation of the brines, even under the most favourable conditions where exhaust steam from lumber mills is used for evaporation purposes. Their strength is only one-fifth of that of the Salina brines of Michigan, which are most generally utilized in that state for salt production. Deep drilling farther west on the escarpment has produced sufficient evidence that the original brines are much stronger, and that they are diluted owing to admixture with the upper waters of the groundwater table, before they reach the surface. At Neepawa, at a depth of 1,180 feet a brine of sufficient strength for salt extraction has been obtained, with a head of 880 feet; and similar brines are undoubtedly to be obtained elsewhere on drilling to this horizon. The comparatively large percentage of calcium in the deeper brines will add somewhat to the cost of purification, but there is at least the possibility of the basis of a future salt industry in the underground brines, of the widespread character of which the surface springs are sufficient indication.

The older analyses showed a remarkably high percentage of potassium in the brines from the Winnipegosis district and hopes were entertained that these brines might prove of value on that account. The analyses that have been made from the brines collected since the present investigation began show, however, that the percentage of potassium is by no means abnormal, and is, in fact, considerably smaller than that from the Marshall sandstones of Michigan. Bromine is also present in the brines, but not in sufficiently large quantity for purposes of extraction. If a salt industry were established in connexion with the deeper brines, the only by-product available would be chloride of lime.

LAKE SIMCOE AND RAINY RIVER DISTRICTS, ONTARIO.

(W. A. Johnston.)

During the field season of 1914 about two and a half months were spent in areal mapping of the topographically surveyed areas of Lake Simcoe district, Ontario. In this district the geological work has been extended to include the mapping of the unconsolidated or drift deposits as well as the solid rocks, partly with a view to delimiting the agricultural and non-agricultural land and the different soils, sand and gravel deposits, etc. The map-areas completed include the Orillia, Brechin, and Kirkfield and the greater portion of the Beaverton area.

During the latter part of the field season about six weeks were spent in completing the mapping of the calcareous drift areas between Rainy lake and Lake of the Woods, which the geology is well known and thereby ensuring a correct comparison of the surface geology of the region was given in the Summary Report for 1913.

A RECONNAISSANCE OF THE NORTH SHORE OF LAKE HURON.

(W. H. Collins.)

During the field season of 1914 the writer explored portions of the country along the north shore of Lake Huron between Sudbury and Sault Ste. Marie. The work was undertaken partly to obtain information about the geology of this interesting, though little known region, but more particularly for purposes of geological correlation.

The most thorough field work in northeastern Ontario (Timiskaming region), and that which best elucidates the geological history, has been done where mining operations have called for a precise knowledge of the local geology. These mining areas are mostly small and isolated from one another by large intervals of comparatively unknown country. Their isolation rendered it expedient for geologists, in order to avoid mistakes in the use of stratigraphic names, to adopt independent rock-classifications and terminologies in each district. In some cases a classification current in one district was adopted in a new district, but this procedure was usually attended with more or less error. The complexity of formational names, and errors in the use of some of these which have resulted, can be dispelled only by determining the equivalence of those names now in use in different parts of the region and reducing them to common terms. Until this is done no general geological map of the region can be satisfactorily compiled nor any coherent geological account of it be written. And it can be done reliably only by exploring the intervals between the isolated districts in which the geology is well known and thereby ensuring a correct comparison of the geological sequences in each.

The geological sequences of the important Cobalt and Sudbury mining districts were correlated in this manner by the writer and his assistants between 1908 and 1913; and in 1914 the Sudbury district was connected up with the Original Huronian district near Sault Ste. Marie, first studied by Logan and Murray between 1847 and 1858. Instead of exploring continuously across the interval of 125 miles between the Sudbury and Original Huronian districts, results were obtained more expeditiously by studying a number of small areas spaced fairly regularly across it. The geology in each area was mapped, the sequences of formations determined and, as far as conditions admitted, the thickness of the various formations were measured. A certain amount of less intensive exploration between these areas was also performed to supplement the information obtained within them and to make their comparison more certain.

Altogether, five areas were studied and mapped, as follows:—

1. Bruce area, near Bruce Mines, area 156 square miles.
2. Blind River area, near Blind River, area 135 square miles.
3. Whiskey Lake area, 15 miles north of Cutler, area 30 square miles.
4. Espanola area, near Espanola, area 35 square miles.
5. Round Lake area, near Naughton, area 42 square miles.

The performance of an important share of this work is due to the able assistance given by T. T. Quirke and W. E. Cockfield throughout the season. The micrometer surveys of lakes and streams and telemeter surveys of roads necessary to furnish a geographic base map were conducted with equal satisfaction by J. R. Marshall and H. J. Heath. The opportunity is taken also to thank Mr. J. A. Reddington, manager of the Long Lake gold mine, for facilities offered in examining the mine and mill under his management; Mr. Appleton, manager of the Lake Huron and Northern Ontario railway, for conveniences placed at the party's disposal; and Mr. Arthur Teasdale for much useful information concerning the country.

THE MIDDLE AND UPPER SILURIAN OF SOUTHWESTERN ONTARIO.

(*M. Y. Williams.*)

PURPOSE OF WORK.

The geological investigation of the middle and upper Silurian of southwestern Ontario carried on during the field season of 1914, was a continuation of the work done on the lower formations of the Silurian during the past two summers. The gap has now been filled between the Niagara escarpment and the Devonian formations which have recently been studied and mapped by C. R. Stauffer. The geological formations studied are of growing interest to the public including as they do, the sources of salt, lime, gypsum, cement, and crushed stone for concrete, and road metal.

NATURE AND AMOUNT OF WORK DONE.

In the course of the field work the country was carefully searched for outcrops of bedrock which when found were studied and mapped. Gravel deposits were also studied and located, those near the towns and villages being given special attention. About 200 gravel pits were thus surveyed, the information gathered to be included in a report on the road metal of Ontario now being prepared by L. Reinecke.

The area surveyed lies between the extremities of the Bruce and Niagara peninsulas and includes a strip along the shore of Lake Huron extending from Southampton to a point a short distance south of Goderich. A small area in the vicinity of Amherstburg was also studied. In all, over 7,300 square miles of territory were investigated and mapped during the four months that the writer's party was at work. During the month of October, the writer made comparative studies on the Silurian formations, of Wisconsin, Illinois, and Lake Timiskaming, Ontario.

ACKNOWLEDGMENTS.

Among those to whom thanks are due for assistance and courtesies received special mention should be made of the following gentlemen: Mr. R. E. Haire, manager of the Alabastine Company of Paris, and the manager and foremen of the Caledonia mine belonging to this company; Mr. Hambleton, manager of the Hagersville Crushed Stone Company, of Hagersville, Ont.; Mr. S. W. Howard, of Hagersville; Messrs. Thos. Nattress and Geo. McMillan of the Amherstburg stone quarry, of Amherstburg, Ont.; Mr. J. W. Foley, manager of the Sibley quarry, Sibley, Michigan; Messrs. Shattuck, Lang, and Goodwillie, of the Solvay Process Company, Detroit, Michigan; Mr. F. L. Snively, of Dunnville, Ont.; Mr. E. E. Teller, Milwaukee, Wisconsin; Prof. Stuart Weller of Chicago university; Messrs. Langford and James H. Ferris of Joliet, Ill.; Dr. W. G. Miller and Messrs. T. F. Sutherland and W. R. Rogers, and others of the Bureau of Mines of Ontario; and Mr. Arthur Cole, mining engineer to the Timiskaming and Northern Ontario railway; Mr. Whelihan of St. Marys; Mr. James Gow, of Fergus; the managers of the Ontario Peoples Salt and Soda Company of Kincardine, and the Rice Salt Company of Goderich. Besides the above numerous others aided the writer and his party in various ways.

The writer was ably assisted in the field by Messrs. George S. Hume, O. D. Boggs, A. H. Bell, and W. T. Graham, who were employed for four months and Mr. J. K. Knox who was employed during the month of June and was then transferred to L. Reinecke's party.

GENERAL GEOLOGY.

The formations under consideration are, in ascending order: Guelph, Salina, Monroe. The Guelph is generally considered to be of middle and the others of upper Silurian age.

Guelph Formation.[1]

The Guelph is entirely composed of dolomite which varies from buff coloured and fine grained to light grey or white, coarsely crystalline and porous rock. It is generally brownish and somewhat bituminous at the base, the bedding varying in thickness from a few inches to several feet, with an average of about 1 foot. Near Hagersville, the formation as indicated by boreholes, is about 185 feet thick.

The Guelph formation has its most typical development in Ontario and outcrops over a large area, the centre line of which falls approximately through a point about 6 miles south of Hamilton, westward and northward, through Galt, Guelph, Fergus, Waldemar, east of Durham and through Allenford and Chiefs point on Lake Huron. The width of the area of outcrops varies from 2 to 3 miles, in the Hamilton region, to 4 miles at Guelph, 16 miles at Fergus, 20 miles at Durham, and 3 or 4 miles at Allenford. At Chiefs point an area of Guelph extends east for more than 12 miles. Northward, up the west side of the Bruce peninsula, irregular, more or less isolated areas of Guelph occur north of Wiarton, south and north of Pikes bay, and north of Stokes bay to Tobermory including the western two-thirds of that part of the peninsula.

From the Hamilton area east, the Guelph is poorly defined at the available outcrops, which occur only along Twentymile creek and the Niagara escarpment. Practically no fossils occur in the upper beds to help in their identification, but on lithological grounds, the dark, bituminous dolomites found along Twentymile creek above thin beds, are considered Guelph. At the Niagara river, the New York State Geological Survey places certain beds above the falls in the Guelph. In New York state two horizons of Guelph fossils have been reported with Lockport fossils between.

The Guelph dolomites are very similar lithologically to much of the underlying Lockport formation, and at many localities they are identified only after prolonged investigation. They, however, rest conformably upon thin, dark-coloured, argillaceous dolomites which form the top of the Lockport. These are bituminous at many localities and in places have a decided slaty appearance. Dolomites above such beds may safely be considered as Guelph. Besides the position of the Guelph formation, there occur in it a number of characteristic fossils.[1] Unfortunately these are not evenly distributed and are in many cases very fragmentary. In the Bruce peninsula, rock outcrops are large and very numerous. Elsewhere Guelph exposures are generally small and occur mainly in the stream valleys.

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[1] Logan, Sir William, Geol. Surv. of Can., Report of Progress from its commencement to 1863, pp. 336-344.

Salina[2] Formation.

The Salina formation, which contains at various places, lenticular deposits of salt and gypsum, consists of soft grey dolomites, soft green shales interbedded with gypsum, and firm, slate-grey shales which break into irregular pieces. Where salt is present, it is interbedded with marls and dolomites containing some anhydrite or gypsum.

The Salina formation rests on the Guelph, but on account of the ease with which it is weathered down, the contact is everywhere obscured. The lowest beds appear to be light grey dolomites. The Salina is overlain by the waterlime beds, known near Niagara river as the Bertie dolomite, and in the west as a division of the Lower Monroe. In the vicinity of Hagersville, the Salina is about 300 feet thick as indicated by well borings, and at Goderich it is more than 950 feet in thickness as indicated by the salt wells. The thickness of the Salina is very variable as indicated by well records from different parts of the country. The formation outcrops at Caledonia, Paris, and Cayuga, and may be represented by the lower beds exposed along the Saugeen river between Ayton and Neustadt. Although the actual outcrops are limited, a large area of country extending westerly from the Guelph area is underlain by this formation.

Monroe Formation.

The highest Silurian strata of Ontario, according to previous writers, are included in the Monroe[3] formation. This is of variable characters but is well represented in the Amherstburg region by the following section: a lower division of about 260 feet of dolomites containing some chert and thin sandstones; a middle division of pure white sandstone 75 feet thick; and an upper division of 135 feet of dolomites overlain by 39 feet of very pure limestone, known as the Anderdon[4] limestone. The dolomites are in general of a light buff colour and occur in beds from 1 to 2 or more feet thick. The Anderdon limestone is light grey or bluish grey, the beds averaging 2 to 5 feet in thickness.

Except for the quarries in the Anderdon limestone, the Livingstone channel, excavated in the bed of the Detroit river by the American Government (much of the material from which is piled above water level), the Detroit salt shaft sunk many years ago, and some islands in Lake Erie, the Monroe formation in the Amherstburg region is known only from well records. Because of the similarity in the general characters of the Monroe dolomites and those of the Salina formation upon which they rest, it is difficult to say definitely where the boundary between the two formations lies. Minor divisions have been made in the Monroe[5] but in the present discussion they will not be considered.

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[1] See Logan, Sir William, Ibid.
Guide Book No. 4, Excursions in Southwestern Ontario; Geol. Surv., pp. 118-120.

[2] Dana, J. D., Manual of Geology: Revised edition, 1864, p. 246.

[3] Lane, A. C., Mich. Geol. Surv., Rept. State Board, 1891-92, p. 66.
Grabau, A. W. and Sherzer, W. H., Michigan Geol. and Biol. Survey Publication 2, Geol. Series 1, 1910.

[4] Grabau, A. W. and Sherzer, W. H., Ibid, p. 42.

[5] Grabau, A. W., Ibid.

The top of the Anderdon limestone at the Amherstburg quarry, shows peculiar channellings and cavities filled with sand, and is generally overlain by a thin covering of sand which is mingled with the base of the overlying Onondaga or Dundee limestone. These indications of erosion and rapid sedimentation are altogether lacking at the Sibley quarry of Michigan, where the Dundee rests upon a horizon of limestone not more than 2 to 3 feet higher than the top of the Anderdon in the Amherstburg quarry. The Anderdon limestone and the beds cut in the Livingstone channel carry considerable faunas, which include both Silurian and Devonian types.

The Bertie[1] dolomite exposed in the vicinity of Buffalo, near Hagersville, and on the Saugeen river between Paisley and Glen Eden, has been correlated by Grabau with the Put-in-bay dolomites of the Lower Monroe. The Bertie is generally less than 50 feet thick, and consists of rather thin-bedded, grey or buff-coloured dolomites, commonly having bituminous partings. In the township of Bertie, 4 or more feet of thin-bedded, bituminous shales occur near the top. Some of the dolomite beds were formerly used for waterlime and contain the fossil *Eurypterus remipes*. At one horizon, the dolomite has been found by the writer to contain some small brachiopods.

As with the Monroe formation farther west, it is not possible from evidence obtained from borings, to say definitely where the boundary between the Salina and the Bertie strata should be drawn. The Bertie dolomite is overlain unconformably by Oriskany sandstone or where this is absent, by Onondaga limestone.

ECONOMIC GEOLOGY.

Crushed Stone for Road Metal and Concrete.

The fine-grained dolomites of the Guelph formation are found when crushed, to furnish excellent material for road metal and concrete. They are very hard, have sharp clean fractures, pack well, and are resistant to wear. The absence of calcareous deposits leaves the binding surfaces clean for concrete work.

Such beds are extensively worked at Mr. James Gow's quarry at Fergus. Here the large blocks are burnt for lime, the smaller materials along with the overburden of gravel are crushed and screened, the sizes too fine for road metal and concrete being sold to the Corinth Stone Company of Guelph, for the manufacture of artificial stone. Beds of similar character (although not at all of the same high grade) occur in the vicinity of Rockton, Galt, Preston, Hespeler, Elora, Waldemar, Holland Centre, and at practically every Guelph area on the Bruce peninsula.

Building Stone.

Formerly considerable building stone was obtained from the quarries in the Guelph formation at Guelph and elsewhere. This material is suitable for decorative work as well as for ordinary dimension stone. The beauty and good wearing qualities of this stone are well illustrated in the vicinity of Guelph and Fergus, in the walls of buildings made of it. Stone suitable for building purposes may be found at almost every locality where Guelph outcrops are reasonably extensive.

Stone for Lime Manufacture.

The Guelph, Bertie, and Anderdon beds are all quarried for the manufacture of lime. The dolomites in the vicinity of Guelph are extensively worked by the Standard White Lime Company, both from hydrated and ordinary lime. At Puslinch, Galt, Fergus, and many other places, lime-kilns are using the Guelph dolomites and abandoned kilns scattered over the Guelph areas are evidence of the former widespread use of this formation for local lime supply.

The Bertie beds are no longer used for natural rock cement, but suitable rock from this horizon is still burnt to some extent for quick-lime as, for example, at Teeswater. This lime is very white and is said to set well.

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[1] Chapman, E. J., A popular and practical exposition of the minerals and Geology of Canada, p. 190, 1864.

Beds referred to the Upper Monroe, or Anderdon limestone are burnt for lime at Beachville by the Standard White Lime Company.

High Grade Limestone.

The Anderdon limestone of the Upper Monroe formation is known in the vicinity of Amherstburg to be nearly pure calcium carbonate. Judging from field evidence, the same high calcium content is present in the beds correlated with the Anderdon, at Beachville, and at areas along the shore of Lake Huron extending 8 miles north from Goderich and from 8 to 12 miles north of Kincardine.

Gypsum.

The gypsum deposits of the Salina formation were formerly worked in the vicinity of Paris and Caledonia. The mining operations at Paris have been abandoned for some years, but extensive mining is being carried on by the Alabastine Company, of Paris, at Caledonia. The products are kalsomines, wall plaster, plaster of Paris, land plaster, etc.

Three well-defined beds occur at Caledonia. The upper bed which is mixed with limestone is about 6 feet thick and was formerly mined. Below this is a 3-foot bed of limestone above 4 feet of mixed limestone and gypsum. Below this, again, is a 7-foot bed of gypsum with thin limy partings and limy accumulations. This bed is extensively mined. Below this bed are 10 feet of brown limestone containing some gypsum. Below this again is a 3-foot bed of fine white gypsum below which is a 4-foot bed of dark limestone underlain by a 3-inch bed of gypsum. These two lower gypsum beds with limestone between are being worked as the lowest level of the mine.

The Crown Gypsum Company is mining gypsum at a locality about 1 mile southwest of York, Haldimand county. The workings are 72 feet deep 20-30 feet of this being through overburden of surficial deposits. The gypsum is white and occurs in a bed about 5½ feet thick.

Salt.

Lenticular deposits of salt have long been known to occur in the Salina formation. Salt evaporation is being carried on at Kincardine by the Ontario People's Salt and Soda works, and at Goderich by the Rice Salt Company and the Purity Flour Company. At the former town the salt bed, which is 14 feet thick, is 993 feet from the surface, the surficial deposits being 90 feet thick. At Goderich, there are six beds of salt as encountered in the Attril well. These occur at 997, 1,060, 1,092, 1,207, 1,230, and 1,379 feet from the surface and are respectively 31, 25, 35, 16, 13, and 6 feet thick. It is the second bed from the surface which is said to be worked by the Rice Salt Company. Marls and limestones are interbedded with the salt, and some beds of gypsum and anhydrite occur.

Salt[1] has also been obtained in Huron county from wells in Wingham, Blyth, Clinton, Seaforth, Hensall, and Exeter. At these localities the salt which varies in thickness from 30 to 116 feet, is struck at depths varying from 1,035 to 1,214 feet below the surface. In Middlesex county, 100 feet of salt was struck in the London Asylum well at a depth of 1,400 feet below the surface; and at Glencoe, 104 feet of salt with shale was struck 1,290 feet below the surface. In Lambton county, beds of salt mixed with shale were struck as follows: At Port Frank 110 feet thick, 1,245 feet from the surface; at Petrolia, two beds 105 and 140 feet thick at 1,180 and 1,365 feet from the surface; and at Courtright 22 feet thick at 1,630 feet from the surface. In Essex county, Windsor, 40 feet of salt was struck at a depth of 1,127 feet and in another well, 30 feet was struck at 1,055 feet, 75 at 1,110, 70 at 1,320, and 252 at 1,420 feet below the surface.

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[1] Taken from Report of the Mining and Metallurgical Industries of Canada, Dept. of Mines, Mines Branch, 1907-8, table, p. 417.

INVESTIGATION OF THE CLAY RESOURCES OF ONTARIO.

(J. Keele.)

The field season of 1914 was confined to an examination of the clay and shale deposits of southern Ontario, and the industries that are dependent on these deposits.

The raw materials of the clay-worker in this region are drawn from two extensive, plastic-shale formations, the Queenston and Lorraine, and from soft, lacustrine clays of Pleistocene or later age.

The workable deposits of shale are confined to two principal areas, one of varying width along the shore of Lake Ontario, between Toronto and Beamsville, and the other bordering the shore of Lake Huron, between Collingwood and Owen Sound.

Areas of Queenston and Lorraine shale of less extent occur in the vicinity of Ottawa, and on Manitoulin island.

The most important group of clay-working plants in the Dominion, is located on the first mentioned area. There are two reasons for this: (1) the raw material, which is abundant and easily accessible, is well suited to the manufacture of rough clay products for structural use; (2) the cities of Toronto and Hamilton afford excellent markets for the wares produced.

The shales of the Cataract formation, which lie just above the Queenston shales, are not used at present. These are grey, plastic shales, with good working, and drying qualities, burning to a hard dense body at low temperatures. They appear to be well suited for certain kinds of clay products, such as fireproofing.

The material is not very accessible, as it generally occurs in an escarpment, underlying dolomites or limestones.

Very interesting deposits of shale of Devonian age occur along the river Aux Sable between Thedford and Arkona. This is highly plastic, red--burning material, apparently well suited to the manufacture of field drain-tile, but is not utilized.

The widely spread Pleistocene clays are utilized in many localities for the manufacture of common bricks or field drain-tiles. These are of varying quality, their chief defects being an excess of lime in their composition in some localities, or the presence of pebbles, which in other localities renders them unworkable.

The most valuable occurrence of this material in the province is the thick red-burning deposit of interglacial clay found underlying the eastern part of the city of Toronto. This kind of clay was sought for during the season in various parts of the province; but, so far, it has not been found outside the Toronto area.

About 80 samples of clays and shales were collected during the season. These will be subjected to a series of physical tests in the laboratory, and a full report on their properties and uses will be issued later.

A considerable part of the season was given to a study of the superficial deposits of the region, for the purpose of drawing up a form of classification for use as a basis in further work on clays, soils, sands, and gravels. The glacial history and sequence of these deposits proved so complex that a certain amount of detailed work on a smaller area will be necessary before arriving at a decision.

Very little attention has been given to these deposits since 1863, and the classification then adopted, which was probably satisfactory at the time, is now found to be quite inadequate for the purpose we have in view.

At the request of the Chief Engineer of the Hydro Electric Commission of Ontario, a geological examination was made of a portion of the drainage basin of the Beaver river near Eugenia falls. A considerable body of water is to be impounded on the plateau at this point, for use as a storage basin in the development of power.

Norman B. Davis was field assistant during the season; his work was satisfactory in every respect.

ROAD MATERIALS IN ONTARIO.

(L. Reinecke.)

INTRODUCTION.

Within the last few years there has been a great awakening to the need of better roads in the various provinces of Canada. Two of the provinces, Quebec and Ontario, now have official departments or bureaus whose business it is to supervise the building of their country highways, and it is probable that other provinces will soon follow the good example set them by these two.

The materials with which the great majority of highways are surfaced, are broken stone and gravel. Certain gravels and some kinds of stone are tough and hard, and may be used upon roads subjected to heavy travel, others are softer and soon wear out under the abrasive action of the traffic. The taxpayer and road builder are interested, first, in the relative cost of placing any one of a number of available types of broken stone upon a particular road to be constructed, and, second, in the relative service or wear that can be obtained from them after they are on the road. A local stone, even if rather soft, can sometimes be used to advantage to cover a country road. If the traffic over the road is light, the surface may last long enough to repay the neighbouring taxpayers, in the time and money saved in hauling their produce, for the cost of building. If the traffic is heavy, the surfacing with a soft stone may mean a great waste of money, for under such conditions a road surfaced with soft stone may wear out and need resurfacing, in a year or less.

It is, therefore, important, that the deposits of stone and gravel occurring in the more thickly populated districts of Canada be studied to determine their road-making qualities, and mapped to enable road-engineers to estimate the amounts available and the distances of the deposits from prospective roads.

The officers of the Geological Survey have been studying occurrences of stone and gravel in all parts of Canada, for more than half a century, and have much information of this kind at hand; they are, therefore, able as an organization, to carry on the work of further explorations in this department to advantage.

A general survey for road materials was begun this year and the result of the first season's work is given below.

METHOD OF PROCEDURE.

The plan which is being followed is to co-operate with the Provincial Highway departments, and to carry on the surveys in such a manner that the information obtained can be put to immediate use in road-building operations. For example, a report upon the materials available for a concrete road, which is now being constructed between Toronto and Hamilton, was furnished to the Provincial Highway Commissioner last autumn, and another up on a road from Toronto to Oshawa, will be transmitted to his department this winter. Both reports are based upon surveys made last summer. Besides work of this kind, detailed surveys have also been made of particular counties and a general survey in order to locate deposits of high grade material.

During the last field season, the work has been entirely confined to Ontario, but the department expects to make explorations in both Ontario and Quebec next summer, and in other parts of Canada.

The information obtained will be on file at the office of the Geological Survey, and will under suitable restrictions, be available to the public. Reports upon materails for special highways will be furnished those engaged in building them wherever it has been possible to do the necessary field work, and the Survey will print reports upon the road metal deposits available in certain districts. These districts will probably comprise one or more counties, or may embrace a whole province, the report in such cases being a more generalized account of the better classes of road materials in the province.

FIELD WORK.

Field work was begun on June 30, and ended on October 13, and several short trips were made later in the autumn. A prospecting trip for deposits of trap rock was made along the north shore of Lake Huron, and detailed surveys were made of Essex and Kent counties and of a strip from 2 to 5 miles wide on the north shore of Lake Ontario, between Trenton and Hamilton.

Information regarding road materials was also obtained by the parties doing geological field work under the direction of Mr. M. Y. Williams, in southwestern Ontario, and those under Mr. W. H. Collins, along the north shore of Lake Huron.

In the field work, the writer was assisted by Mr. J. K. Knox, and because of the distances which separated the localities where the surveys are required, it became necessary to have Mr. Knox work on the area north of Lake Ontario with but little supervision or assistance. It is a pleasure to state that his work was done in a thorough and painstaking manner.

The writer wishes to thank Mr. John Millen, of Sandwich, and other Essex County officials, and also Mr. M. E. Brian, the city engineer of Windsor, for their courtesy and assistance. His thanks are due also to many town officials and farmers in Essex and Kent counties, for information regarding deposits of gravel on their properties.

The following is a brief résumé of the season's work. Information in greater detail upon road materials within the areas visited is on file in the office of the Survey and is available to those engaged in road building upon application to the Director of the Geological Survey.

North Shore of Lake Huron.—Deposits of trap rock were examined along the north shore, and on the outlying islands, from a point north of Little Current to Blind River, and at Thessalon, Nestorville, and Bruce Mines.

At Bruce Mines a large quarry is now in operation with a crushing plant capable of handling 500 tons per hour. The quarry is on the water's edge and the crushed stone is loaded directly from the plant into large barges. The material is of very good quality for road and concrete work. The prices quoted to the writer in July, 1914, were $1 and 80 cents respectively per ton f.o.b. quarry for two grades, the higher price being charged for four sizes of material from less than ¼ inch to 1½ inches. Freight charges by boat without unloading were 35 cents to Detroit, and 40 cents to Cleveland.

Other deposits of trap rock were found which contained several million tons of diabase, lying on the shores of islands, and on the mainland. In most of them it would be possible in quarrying to obtain from 30 to 50 foot faces above the water level. Some of them lie near deep, natural harbours where docks could be constructed at low cost for boats drawing up to 20 feet of water. In other words, the deposits offer very excellent chances for economical quarrying, and for cheap transportation by water of the crushed rock. There is no doubt that practically all the diabase will make excellent road material.

A Geological Survey party under the direction of Mr. W. H. Collins mapped strips of country from 5 to 10 miles wide along parts of the railway line between Bruce Mines and Sudbury. Areas of trap rock, of which there are many, were mapped within these strips and notes made on a few gravel deposits. A trunk highway following the railway is now under construction between Sault Ste. Marie and Sudbury.

The local road materials which are available for the lake port towns of southwestern Ontario are as a rule of very poor quality and as the population of this portion of Ontario increases, the need for first class road materials will be felt more keenly.

First class trap rock can be transported by boat from the north shore of Lake Huron to points on Lakes Huron and Erie in old Ontario at a cost which will be very little higher, and in some cases lower than the freight charges by rail for inferior local material. When used in macadam roads subjected to heavy traffic, trap rock is very much superior to the local materials. Its greater durability in cases of that kind far outweighs its greater cost. It is of importance that builders of roads should realize the importance of the north shore as a source of supply for road material of high grade.

Essex and Kent Counties.—The bedrock in Essex and Kent counties is covered by from 50 to 200 feet of clay and sand with occasional patches and ridges of gravel. The only bedrock available is at Amherstburg, and on Pelee island. The Amherstburg material is of poor quality. The limestone on Pelee island has not yet been tested, but it is rather soft under the hammer and will probably not do for heavy traffic.

There is a ridge of sandy gravel between Essex village and Leamington, most of which is of poor quality. Scattered deposits of field stone were seen in the neighbourhood of Kingsville and very sandy gravels at the town of Sandwich, and to the south and east of it. Essex county contains no really first class road material.

An area of gravels occurs in the southeastern part of Kent county, south of the Pere Marquette railway. These gravels lie in ridges which are all sand and gravel, or occur as patches of gravel in clay ridges. Most of these gravels if not too sandy, make good light traffic roads, but are not durable enough for heavy country traffic, such as that between the villages of Blenheim and Ridgetown. The best gravel in the county seems to be that found on the Talbot road a few miles east of Morpeth, which not only wears, but cements well. Good gravel is found on the Lake Erie beach, but it occurs in small amounts. Sandy gravels occur in the beds of the Thames and Sydenham rivers, and areas of sand and gravel to the northeast of Ridgetown.

By far the greatest part of these two counties is underlain by boulder clay, and the roads in these sections are almost entirely unsurfaced, that is, they are clay roads. These clay roads are very sticky and slippery in wet weather, and although most of the gravels found in Essex and Kent are too sandy, and not durable enough, for good macadam work, they will greatly improve a clay road if properly placed upon it. All the areas of sand and gravel in the two counties were, therefore, carefully examined and mapped.

The North Shore of Lake Ontario.—A narrow belt of gravel extends along the shore-line of Lake Ontario from Trenton to Niagara Falls and beyond. The gravels lie with sand, in long narrow bars along the winding shore-line of an ancient extinct lake (Lake Iroquois). The old shore is from 2 to 7 miles from the present shore of Lake Ontario, and 116 to 400 feet in elevation over it. This belt lies along one of the principal avenues of traffic in Ontario, and the character of the gravels is, therefore, of particular interest. They have been examined and mapped from Trenton to Hamilton.

The deposits are practically entirely of sand and gravel, the sizes of the material varying greatly from place to place. Clay is present in a few deposits only, but lime is very frequently found in greater or less amounts as a coating on the gravel pebbles. A small percentage of clay is an advantage in gravel used for the building of gravel roads. In concrete work of any kind, however, clay is a distinctly undesirable ingredient, and it is probable that a coating of calcium carbonate pebbles is also a source of weakness.

The relative durability of the gravels in this belt has been estimated from the relative proportions of the hard and soft pebbles in them, and from the way in which they wear on road surfaces. The more durable gravels appear to be those at the east and west ends of the city of Toronto, and from there west to Erindale village.

From Trenton to Toronto they are rather uniform in composition and in probable wearing qualities. The poorest gravels lie in three bars between Burlington and Oakville.

The party under Mr. M. Y. Williams examined the broad belt in southwestern Ontario, southwest of the Niagara escarpment. Their work was not primarily concerned with road materials, but they incidentally located and examined a large number of gravel deposits. The belt so mapped is from 25 to nearly 100 miles wide and stretches from the Niagara river to Bruce peninsula.

INVESTIGATION OF THE OCCURRENCE OF RADIO-ACTIVE MINERALS IN ONTARIO.

(*S. Brunton.*)

INTRODUCTION.

Since the discovery of radium in 1898 much interest has been taken in minerals which contain this substance and many governments have encouraged the search for radium minerals and have undertaken their conservation. The Governments of Ontario and British Columbia have offered bonuses for the first discovery of radio-active ores in commercial quantities in these provinces.

During the summer of 1914 two field parties of the Geological Survey made examinations for radio-active minerals. The first under C. W. Robinson visited different localities in Nova Scotia and Quebec and the second party under S. Brunton traversed the territory in the province of Ontario lying between Fort William, the National Transcontinental railway, and the southern boundary. This report deals with the results of the last-named investigation.

Work was commenced in the beginning of June, 1914, and continued until the middle of October. The first two weeks were spent at McGill University for the purpose of making and testing the necessary instruments, under the guidance of Professor A. S. Eve, to whom especial thanks are due. Very valuable assistance was also received from Mr. Arthur A. Cole at Cobalt, Mr. J. F. Robertson, smelter superintendent at the Mond Nickel Company's smelter at Coniston, Mr. J. A. Dresser of the Algoma Central railway at Sault Ste. Marie, Mr. C. Spearman at Kirkland lake, and many others.

The territory covered in this search comprised several districts in Ontario from which radio-active minerals had already been reported, and others in which it was considered that a careful search might reveal such minerals. In each area a thorough investigation was made in the most likely localities and particularly in the ores and waste dumps of mines, and in the concentrates from ore-dressing plants; all minerals which seemed at all likely to show radio-activity were tested in the most delicate apparatus which it was possible to transport from place to place.

THE COBALT AREA.

The first district visited was the Cobalt silver area. Here the rocks are Keewatin and Huronian and are cut by a diabase sheet which is supposed to be the ore-bringer. This area is similar to that of Joachimsthal—Schneeberg in the Bohemian—Saxon

Erzegebirge; but in the latter place the ores have been brought in associated with a Permian granite, while the ore-carrying rock at Cobalt is of a much more basic composition. Eighty-five tests were carried out in this district and none showed the presence of radio-activity in any quantities. It is, therefore, probable that deposits of radio-active ores will not be found in this locality.

THE PORCUPINE GOLD AREA.

This area also lies in the Pre-Cambrian shield, but the occurrence of the ore deposits seems to depend more upon the structure than the actual composition of the rocks. The ore shoots apparently exist in zones of faulting which have been impregnated by mineral bearing waters or vapours. The deposits are genetically connected with quartz porphyries and other intrusives of an acid character, and the existence of considerable quantities of tourmaline in places bears out the idea of pneumatolitic or pegmatitic origin; but no uncommon minerals have been found with the exception of scheelite (calcium tungstate) which occurs in small quantities.

Although no radio-active minerals have been found in the district up to the present time the genetic relations do not preclude the possibility of finding such minerals, and it is quite possible that further prospecting and development may bring them to light. Forty-three tests were made in this district.

SWASTIKA, SESEKINIKA, KIRKLAND LAKE.

During the last few years operations have been conducted at Swastika and Kirkland lake with the object of working the telluride ores of gold. The region of Sesekinika opened up this summer, owing to the finding of tellurides. The presence of tellurium and the association of the ores as impregnations from quartz porphyries favour the possibility of finding radio-active minerals, but none of the tests carried out in the localities showed any radio-active indications.

POINT MAMAINSE AREA.

In 1847 Dr. J. L. Leconte described, under the name of coracite, a new mineral supposed to be from this area (see Report of the Geological Survey for 1863). The mineral was said to occur in a vein 2 inches wide, but it has never been found since first reported. The area in which Point Mamainse is situated, lies at the eastern end of Lake Superior about 65 miles north of Sault Ste. Marie, and was reached by a small steamer which plies between the latter port and Michipicoten harbour.

The outcrops at the Point Mamainse locality comprise Pre-Cambrian rocks, with pegmatites carrying considerable quantities of muscovite. The pegmatites are of the usual type found all through the Laurentian protaxis, and no minerals were found which would especially indicate the presence of radio-activity. The only mineral in the pegmatites besides the usual quartz, feldspar, and mica, is graphite, which is scattered through the rocks in small flakes. Point Mamainse itself is composed of Keweenawan lava flows similar to those found on Keweenaw point. Native copper occurs there and the rocks are cut by veins of calcite some of which carry ores of copper. The veins are barren of radio-active minerals. Twenty tests were made in this area.

THE BRUCE MINES.

These mines are now closed and full of water; but the tailings are still used by the Mond Nickel Company as fluxes. The ore apparently occurs in connexion with quartz veins, and comprises various copper sulphides. No indications were found of radio-activity in the ore, nor in the tailings at the smelter. Five tests were made in this area.

JACKSONBORO.

A trip was made to Jacksonboro, 32 miles west of Cochrane on the National Transcontinental railway, as reports were in circulation that radio-active materials had been found in that vicinity, but nothing was found which in any way pointed to the existence of such minerals in the locality examined. Three tests were made in this area.

SUDBURY.

The Sudbury Nickel area has often been described as a basin some 36 miles long by 13 miles wide, in which the rocks lie in layers. The most important of these layers is composed of norite from which various ores of copper and nickel, such as pyrrhotite, pentlandite, and chalcopyrite have separated out by magmatic segregation. These conditions are not in accord with those found in any localities where radio-active minerals have been reported to occur.

In none of the mines, in the course of operations, have any specimens of radio-active minerals been discovered, nor do any of the concentrates show radio-activity; and all tests on mineral or rock specimens in this district gave negative results. It is to be inferred, therefore, that this locality also is unfavourable for the finding of radio-active ores.

The deposits of anthraxolite on lot 10, concession I, and lot 4, concession II, Balfour township, were also visited, but the samples gave no radio-active results. Thirty tests were made in this area.

MADOC-MARMORA AREA.

In this region, which is celebrated for its great variety of minerals, many small prospects pits have been dug, and in some instances the mines have been operated for a short time, but at present no operations are being prosecuted.

Uraconite has been reported from the Seymour mine, lot 11, concession V, Madoc township, and from lot 20, concession I, of Snowdon township. Visits to these places revealed radio-active minerals, but the general geological relationships in the vicinity are such that it seems probable that the reports may be founded on fact. A number of large samples were taken which will later be treated by concentration in the hope that in this way radio-active minerals may be isolated. At the time of writing this report the experiments have not been finished, and no definite statement can be made as to whether or not radio-active ore is to be found in these places. The area is composed of granite overlain by Palæozoic limestone (Birdseye and Black River).

CRAIGMONT-BURGESS AREA.

Craigmont lies in the township of Raglan some 45 miles north of Madoc. It is situated in an area of nepheline syenite rocks intermixed with crystalline limestone and schists. Corundum is mined there and a mill was erected at Craigmont for its treatment. A few years ago the mill was burnt down and the plant at Burgess 5 miles west of Craigmont has since been found sufficient to supply the market.

A very small quantity of heavy product resembling metallic lead, but radio-active, is found in the jigs at Burgess. It has not yet been possible to detect the occurrence of this substance in the unconcentrated rock which at best can, therefore, contain it only in minute quantities. Nevertheless it is certain that by concentration a substance is obtained which gives a radio-active value equal to 6.6 per cent of Joachimsthal pitchblende or in other words is approximately equal to a 4 per cent ore of uranium oxide.

Near the village of Quadville on lot 23, concession XV, of Lyndoch township in Renfrew county there is a pegmatite dyke carrying beryl, quartz, feldspar, biotite, muscovite, garnet, fluorite, specular hematite, and tourmaline. Baryite and tantalite are also reported, but none was found during the present investigations. Thirty tests were made in this area.

Two other minerals of importance were also procured here, columbite, and a substance which apparently corresponds most nearly with samarskite, but of which the actual composition has not yet been determined. Both minerals are radio-active, and although little development work has been done, the location appears to warrant investigation as a possible source of radio-active ores.

CONCLUSION.

The ores of radium and any radio-active minerals are uncommon. It is, therefore, not surprising that the greater number of the districts visited did not disclose them, but it is very gratifying to know that there are localities in the province of Ontario where these minerals exist.

The area situated between the towns of Haliburton, Madoc, and Bancroft is of peculiar geological interest, and has been dealt with very fully by Dr. Adams and Dr. Barlow. The dyke spoken of on lot 22, concession XV, Lyndoch township, lies just outside the eastern edge of the map prepared by these geologists. Here the indications are such as to warrant prospecting work being undertaken.

NORTHERN PORTION OF BUCKINGHAM MAP-AREA, QUEBEC.

(*M. E. Wilson.*)

The geological investigation of an area to the northeast of the city of Ottawa, in Ottawa and Labelle counties, Quebec, commenced in 1913, was continued by the writer during the past field season.

In connexion with this investigation—as was pointed out in the Summary Report of 1913—it is proposed that a regional map of a rectangular area extending from the village of East Templeton to High falls on the Lievre river, and from the Gatineau river eastward to a point 2 miles beyond the town of Buckingham, be compiled for publication on the scale of 1 mile to 1 inch. In addition to this areal map, small maps of areas adjoining the most important mineral deposits of the region, are being prepared for publication on scales ranging from 100 to 500 feet to 1 inch.

In 1913, the southeastern part of the areal sheet (approximately the township of Buckingham) was mapped, while in 1914, the work was continued in the northern part of the map-area (East and West Portland and portions of Derry, Bowman, Denholm, and Wakefield townships). Thus, the southwestern portion of the proposed map-area (Templeton and portions of Hull and Wakefield townships) has yet to be examined before the investigation is completed.

Detailed geological maps of the areas in the vicinity of the following mines were also prepared during the season: Battle lake, Lake Rheaume and Maple Leaf mica mines, Villeneuve muscovite-feldspar mine, and Moose Lake mica mine.

The contoured base map upon which the geology of the Moose Lake area was laid down, was that prepared by Mr. L. Reinecke in 1913.

As during the previous season, hearty co-operation was afforded the writer by those engaged in mining in the region. Thanks are especially due to Mr. H. P. H. Brumell, of the Dominion Graphite Company, to Mr. W. L. Parker, to Mr. B. Winning in charge of operations at the various properties belonging to O'Brien and Fowler, to Mr. E. Watt, and to Mr. E. Wallingford of the Wallingford Mining and Mica Company.

I also wish to express my indebtedness to L. V. Ellsworth and F. E. Gardiner, the former of whom assisted in geological work during the season, while the latter performed the surveys necessary to supplement the map of the Lievre river and Templeton phosphate district prepared by Mr. James White in 1891.

THE BASINS OF THE NOTTAWAY AND BROADBACK RIVERS, NORTHWESTERN QUEBEC.

(H. C. Cooke.)

For some years past the Geological Survey of Canada, in co-operation with the Quebec Department of Mines, has been prosecuting detailed exploration in northwestern Quebec, with the object of carrying through one or more complete sections from the geologically well-known districts around Lake Timiskaming to the east shore of James bay, and thence northward to include a strip of the east coast of the bay which could be easily reached by prospectors should the discovery of rock formations of possible economic interest warrant their attention. The work of M. E. Wilson and W. J. Wilson for the Geological Survey, and of J. A. Bancroft for the Quebec department, had extended this exploration by the end of the summer of 1912, from Lake Timiskaming northwards to Lake Abitibi, eastward on a wide belt along the line of the National Transcontinental railway to a point about 200 miles east of the Ontario boundary, and northwards down the Bell and Nottaway rivers to within 50 miles of James bay. In the spring of 1914, the writer was requested to carry forward the work as far as James bay, through the region to the east of the Nottaway river, paying particular attention to the hitherto entirely unexplored lower courses of the Broadback river.

Past work in this region has been confined to a geological and topographical reconnaissance made by Robert Bell, in 1896, of the canoe route from Gull lake to Rupert bay, via Lake Evans and the Rupert river; to some incomplete stadia surveys of the same route made more recently by the Quebec Department of Mines; and to a stadia survey of the Rupert river by H. O'Sullivan, in 1906. It was decided, therefore, to make a complete micrometer survey of this route as far as Nemiska lake, and thence down the Broadback river to its mouth. This was done, and at the same time, the geology of the shores traversed was examined in greater detail than formerly. The party returned from James bay by the Rupert river to Nemiska lake and, crossing into the Broadback waters, ascended to Lake Evans. From the southwest bay of Lake Evans, a new and direct route was discovered and explored, leading to Soskumika lake on the Nottaway river. This route is about 75 miles shorter than the one already known between Mattagami lake and Lake Evans, but is easily travelled only in seasons of high water; in low water the streams are very shallow.

The region explored contains little of interest to prospectors, as it is underlain largely by granitic rocks similar to those found in other parts of northern Ontario and Quebec, and commonly classed under the name Laurentian, with only a few small areas of ancient sedimentary rocks and greenstones similar to those in which ores have been found to the southwest. The timber and soil resources are more promising. Much of the land is clothed with a heavy growth of jackpine, black and white spruce, tamarack, balsam, birch, and poplar, the major part of which may be utilized for railway ties, lumber, or pulp; although large areas have been burned over through the carelessness of the Indians in leaving fires unextinguished. The soil is mainly clay; it forms a northward extension of the "clay belt," of stratified sandy clays originally deposited in the bottom of the great post-Glacial lake named by A. P. Coleman, Lake Ojibway. The southern boundary of this belt of clays lies far to the south of the National Transcontinental railway; and its northern boundary has been observed by the writer during the past season and that of 1912, to be roughly the Broadback river, for about 50 miles to the east and the same distance to the west of Lake Evans. A large part of the land in this area is suitable for agriculture, the principal bar to its use being, seemingly, the severity of the climate.

In conclusion, the writer wishes to acknowledge the services of Angus McLeod, whose efficient assistance materially aided the progress of the summer's work.

THE HARRICANAW BASIN NORTH OF THE GRAND TRUNK PACIFIC RAILWAY, QUEBEC.

(*T. L. Tanton.*)

INTRODUCTION.

From June 24 until October 7, 1914, the writer was occupied on a reconnaissance of an area in northern Quebec between latitudes 48° 35′ N. and 50° N., and between longitudes 78° W. and 79° W. This district, which is about 120 miles in length and 40 miles in width, includes the Harricanaw river from the Grand Trunk Pacific railway north to its junction with the Turgeon river, and its tributaries the Wawagosie, Mistowak, Plamondon, Partridge, and Shishishi rivers, together with a small part of the Abitibi basin around Lake Makamik.

The district has been made easily accessible by the construction of the Grand Trunk Pacific railway which traverses its southern boundary. The best places for entering the district are at the Molesworth and Harricanaw River crossings lying 98 miles and 141 miles respectively east of Cochrane. A rapidly growing town, suitable for outfitting purposes, is situated at the latter place.

The purpose of the exploration was to obtain information regarding the regional geology and topography, soil and timber resources, and water powers of the district. The recent discoveries of gold in the upper Harricanaw basin, give the district an interest from an economic standpoint.

The "Carte de la Region de l'Abitibi, 1911, 4 miles to the inch," published by the Department of Lands and Forests, Quebec, was used as a base map for the work and was found to be very satisfactory. Traverses were made in canoes along all the navigable streams, and track surveys were made of those not already mapped. Land traverses extending from 3 to 5 miles back from the water ways were run into areas which could not be reached by canoe.

L. Clermont and L. I. Walker acted as assistants.

GENERAL CHARACTER OF THE DISTRICT.

Topography.

The area is part of a great plain which slopes from the height of land to James bay. The descent in the 120 miles from the south to the north end of the sheet is about 400 feet. The streams make this descent by irregularly spaced falls and rapids with stretches of sluggish water between. The northern half of the region is a great muskeg plain with occasional rocky or clay-covered hills rising less than 100 feet above the general level. The southern half, with the exception of a strip along the railway, is a reign of comparatively high relief. Through this section a well-defined ridge zigzags in a northeast-southwest direction, with low spurs running out on either side. Some of the knobs on the ridge rise over 500 feet above the general level of the surrounding country. The highest of these is Mount Plamondon, with an elevation of 1,700 feet above sea-level and 800 feet above the surrounding country; it is situated 18 miles due north of Lake Chikobee.

Several waterfalls were seen which would be suitable for power development, but of these all but one are too distant from settlements to be of any immediate use. The one exception is the series of rapids about 5 miles in length on the Harricanaw river between 21 and 26 miles north of Harricanaw village. The total drop is over 50 feet. A dam could be built in the granite gorge at the bottom, which would not cause the flooding of any valuable land.

Flora.

The southern half of the district and narrow strips along the streams in the north are well drained and the clay soil which predominates is covered with forests of black spruce poplar, balsam, balsam poplar, cedar, and birch. These trees in certain places have diameters of over 12 inches. Maples, mountain ashes, and willows of small size are abundant in some localities, also many shrubs and berry bushes. Where the soil is sandy jackpine prevails. In the northern half of this district the vegetation consists of sparsely-growing, stunted spruce and tamarack. The forests of the southern half of the district are suitable for pulpwood. The majority of the trees in the northern half of the district are too small to be of value.

Fauna.

The region abounds in game and fur-bearing animals. The larger animals known to be in the region are: moose, caribou, deer, and black bear. Beaver, muskrat, marten, mink, and otter are fairly common, and lynxes, foxes, and wolves are said to be present. Pike, pickerel, whitefish, sturgeon, and various other kinds of fish are abundant. No maskinonge, trout, nor bass are known to have been caught in the region.

REGIONAL GEOLOGY.

Four main classes of rocks are recognized: (1) an old volcanic complex, (2) batholithic intrusions of granite and gneiss, (3) later intrusives, and (4) Pleistocene and Recent deposits.

The oldest rocks of the district (the Abitibi volcanics) include ellipsoidal andesites and basalts, dacites, rhyolites, tuffs, and porphyries in various stages of metamorphism, from comparatively fresh looking rocks to chlorite and sericite schists; also a volcanic mud and dolomite, both rich in pyrite. These rocks make up the majority of the rock outcrops in the district.

Generally speaking, the schistosity strike of the region is N. 65° W., the dip is nearly always vertical.

Batholiths of biotite and hornblende granite and gneiss intrude the Abitibi group in all places where the contact was observed. On Otter lake, large inclusions of rather fine biotite granite were found in a coarser hornblende-biotite granite. This might indicate that all the granites of the region are not of one age. These rocks are extensively found in an irregular belt running east and west across the central part of the district, and in patches in the south central and northwest parts of the sheet.

Of the later intrusives, the chief rock is a quartz diabase. Large dykes intrude the granite on the summit of Otter mountain and along the granite-greenstone contact 4 miles west of Lake Chikobee. Other outcrops occur west of the south end of Lake Obalski, and 3 miles west of the Harricanaw river 10 miles above its junction with the Turgeon river. Other post-Abitibi dykes, whose age relative to the batholithic granites is unknown, were found on the east shore of Lake Kapitisatanan and on the lower Turgeon river. In the former case, a small minette dyke intrudes an acid tuff; in the latter, a fine-grained basic dyke cuts a volcanic mud.

In the southern half of the district, whitish fine-bedded clay with concretions covers all the low-lying land, and may be seen in the beds of most of the streams and on the southwest shore of Makamik lake. Continuous exposures were not found, but in all the outcrops observed the bedding was not horizontal. This may be due to depositional irregularities or to the deformation caused by an over-riding ice sheet. Above the concretion-bearing clay come sandy clay and sand with occasional moraines containing huge boulders. These deposits occur over the whole district, their greatest thickness being toward the south. A section through them on the Shishishi river shows a thickness of 60 feet.

ECONOMIC GEOLOGY.

Although no mineral deposits of economic importance were discovered in the district, it is by no means improbable that such deposits occur. The ellipsoidal andesite, which outcrops abundantly on the Harricanaw river a few miles above and below its junction with the Turgeon river, resembles the gold-bearing rock of West Shiningtree very closely. It was observed to carry numerous, small quartz and calcite veins, and was abundantly mineralized with pyrite. A few veinlets of stiff-fibred asbestos occur in an outcrop of peridotite on the east shore of Lake Obalski about 1½ miles north of the inlet. The volcanic mud on Lake Kapitisatanan carries pyrite; and in one outcrop on the west shore, it is known that for a width of 20 feet the pyrite makes up over 50 per cent of the rock.

Small crystals of galena were found in a quartz vein which cuts a minette dyke intruding the acid tuff on the east shore of Lake Kapitisatanan.

The dolomite which is associated with the volcanic mud on Kapitisatanan lake carries abundant pyrite. On McKenzie lake a shaft has been sunk on a rock of this type but the results of the venture are unknown.

The quartz diabase of this district is lithologically similar to that of the Gowganda district. It carries quartz and calcite veins and, in the exposure 6 miles west of Lake Chikobee, aplite dykes. The diabase, however, occurs as large dykes and not sill remnants as in the Gowganda district.

The glacial lake clays constitute a soil that is suitable for agricultural purposes, and root crops, hay, and oats are raised successfully near the town of Harricanaw and around Lake Makamik. Exceptionally good farm land—gently rolling, sandy clay loam—occurs from 30 to 40 miles north of the railway on the Partridge and Wawagosic rivers.

The lower calcareous clay deposits are suitable for the manufacture of brick.

BROME AND MISSISQUOI COUNTIES, QUEBEC.

(Robert Harvie.)

The past field season was spent chiefly in a continuation of the examination of the geological section across the Sutton Mountain anticline. With headquarters at Cowansville work was begun on June 3, and closed on September 26. In July, 8 days were spent investigating the geology in the vicinity of Ste. Hyacinth where boring activities have been renewed following up the indications of a possible gas field found in 1910 and described in Mr. J. A. Dresser's report.[1] The results obtained were discussed on the ground with Mr. Theo. C. Denis, Inspector of Mines of Quebec. Mr. Clayton B. Hamil, as assistant, rendered thoroughly efficient and enthusiastic service.

The section examined crosses Brome and Missisquoi counties in an east-west direction about 12 miles north of the boundary between Quebec and Vermont. The Sutton Mountain anticline is the continuation in Canada of the Green mountains of Vermont.

The purpose of this work is to determine the relations of the different varieties of rocks occurring in the above-mentioned district, the district having been chosen because the rocks there are comparatively well exposed and are typical of large areas of the Eastern townships. The information obtained there is most valuable, therefore, in solving problems in other localities of economic importance and in supplying data that may be of use in the marble, slate, copper, asbestos, and other mining industries.

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[1] Geol. Surv., Can., Sum. Rep. for 1910, p. 218.

The results of the past season's work are outlined in the following paragraphs.

Apart from the Farnham slates which are known to be of Trenton age, the age of most of the rocks in this vicinity has heretofore been largely conjectural, because any fossil remains that they may have contained have been destroyed by the general regional metamorphism. It was found, however, that the limestone band which passes through the villages of Sweetsburg and Dunham, may be traced along the strike for 40 miles, and is continuous with the Lower Cambrian limestone at the base of the section in Georgia, Vermont, described by Walcott.[1] This connexion was only established after 10 days' structural work on the Georgia section. The examination showed that the lower limestone—No. 1 of Walcott's section—which has an easterly dip, comes up again with a westerly dip in the valley in which runs the Central Vermont railway, east of Georgia Centre, the intervening rocks thus having the form of a synclinal trough. Nos. 1 to 9 of Walcott's section represent one-half the trough and No. 9 which has been painstakingly described as a "lentile," etc., is thus probably only the sharply folded central member of the trough. Of the thickness of 1,000 feet of limestone forming No. 1 of Walcott's section, 780 feet were found in the locality east of Georgia Centre. Going north, however, the band decreases in thickness until on lot 3, range IX, Dunham, 4 miles southwest of Dunham village, not more than 150 feet is found, whilst at Sweetsburg there is estimated to be only about 50 feet. The slates west of and overlying the limestone at Sweetsburg and Dunham are, therefore, the equivalent of the Georgia slates. Beneath the limestone, in conformable descending order, are found the schistose quartzites, dolomitic marble and prophyries and greenstones, more particularly described in the Summary Report for 1913. This succession beneath the limestone was found to obtain also east of St. Albans, Vermont. In the dolomitic marble of the St. Albans section were found sponge-like fossils which have not yet been determined.

It was found that between Cowansville and Farnham, the present surface is very close to that of the plane of a great horizontal overthrust fault by which the Georgia slates on the east have been shoved over the Trenton slates and limestones of the Farnham series to the west. The result of this relation of the fault plane to the topography is to produce very irregular, interfingering geological boundaries. Near Farnham "islands" of Cambrian rocks rest on the Trenton, whilst near Cowansville the Trenton (below) shows through "windows" in the Cambrian (above). This fault is quite distinct from the St. Lawrence-Champlain (latterly "Logan,") fault and to emphasize this distinction the name Cowansville fault is here proposed. No single locality affords complete proof of the occurrence of the fault, but at Cowansville is found the easternmost "window" and it was there that the first clue to the fault was found. The measured throw of the fault is 11 miles, but it seems evident that the actual throw is much greater. The age of the faulting cannot be closely determined, but at any rate it was previous to the intrusion of the Monteregian hills of which it can only be said that they are of post-Helderberg age.

The recognition of this overthrust fault explains away some of the difficulties of the Quebec Group problem. The older geologists not knowing of this fault, unwittingly classed what are now known to be Georgia slates with the Farnham slates—the presence of fossiliferous Trenton rocks in what are now known to be "windows" appearing to them to establish the age quite definitely. Having in their succession, thus jumped the gap between Trenton and Cambrian, it was necessary to explain that the lack of fossils in the lower portions of their so-called Trenton, Chazy, etc., was due to greater metamorphism or some other such factor.

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[1] Bulls., Nos. 30 and 81, U.S. Geol. Survey.

GRANITES OF THE EASTERN TOWNSHIPS, QUEBEC.

(A. Mailhiot.)

The field season, from May 22 to September 27, was spent in a detailed petrographical and mineralogical investigation of the Hereford, Big Megantic, and Scottstown granite areas in the Eastern Townships of the Province of Quebec.

In this work I was assisted by A. M. James and F. C. Donald, and I am very much indebted to them for thoroughly efficient services; Mr. James's intimate knowledge of topography was especially helpful.

As the results of this investigation are almost entirely scientific in bearing they will be published later.

In the Scottstown granite area, good road metal is found. This area is situated on the outskirts of the village of Scottstown covering about one-third of a square mile along the track of the Canadian Pacific railway, east of the station. Quarries could easily be opened in it and railway spurs run into them as the deposit is located close to the main line of the Canadian Pacific railway to St. John, N.B. The rock is apparently a fine-grained pyroxene granite.

The country around Big Megantic mountain has been prospected for alluvial gold at several places, but none of the localities has proved to be promising. The Mountain Creek Gold Field Company operated a washing plant for a few months during the summer 1913 but has ceased operations since. The work done consisted of the excavation of a trench of about 300 feet long, 20 feet wide, and 10 feet deep along the former bed of the Mountain creek, in lot 5, range IV, Chesham township, Compton county.

The Salmon River Gold Field, Ltd., started prospecting last summer on lots 3, 4, 5, 6, 7, 8, 9, range VIII, Chesham township, Compton county.

ST. JOHN MAP-AREA, NEW BRUNSWICK.

(Albert O. Hayes.)

The need of a detailed geological map of the vicinity of St. John, N.B., has been felt for many years. In 1912 a topographical base for this purpose was surveyed and geological mapping was commenced the following year. The results of the writer's first season's work in this distrct are given in the Summary Report for 1913, to which reference may be made for a tentative description of the general geology.

Preliminary mapping of the area was completed in 1913 and in 1914 certain localities were selected for more detailed study. The structural geology is of especial importance on account of the greatly disturbed nature of the rocks of the district, and considerable time was devoted to securing data for its interpretation. Stadia transit traverses were run across portions of the various sedimentary series to map the structure, determine thicknesses, and locate fossil horizons.

One limestone quarry owned by the firm of C. H. Peters and Sons, Ltd., at Torryburn, N.B., and another recently purchased from the city of St. John by the Partington Pulp and Paper Company, located on the north shore of the island of Green

Head, were sampled and surveyed. The former quarry is being worked steadily and the latter has been idle for some years. This work concluded a careful study, begun in 1913, of all the limestone and dolomite quarries near St. John city which are now in operation and some that are idle but may be worked in the future. They number in all five limestone quarries in operation and four idle, one dolomite quarry in operation and one idle.

Igneous rocks, including primary gneisses, plutonic intrusives, dykes, volcanic flows, as well as pyroclastic sediments, cover about one-third of the land surface in the map-area. They have been divided into several groups by previous workers and a preliminary study of these in 1913 pointed out the need of exhaustive field and laboratory investigations in order to determine their nature order of succession, and origin as well as to work out their general structure and age relations. As this work demanded undivided attention, it was offered to and accepted by C. L. Cumming, who had been appointed field assistant, and as a result of his work much important information concerning the igneous rocks has been obtained.

M. C. Foster and H. M. Roscoe were appointed assistants and efficiently carried out the work entrusted to them. Mr. Foster aided Mr. Cumming while Mr. Roscoe worked with the writer.

The writer had the pleasure of studying a number of Glacial and post-Glacial deposits in company with Professor J. W. Goldthwait during three days in June, and gratefully acknowledges his indebtedness therefor. Thanks are due to Mr. A. H. Fitz Randolph for his kindness in supplying two men for one-half day to help secure samples from Green head, and for other courtesies. The writer is also indebted to Dr. G. F. Matthew, Dr. L. W. Bailey, and Mr.Wm. Murdoch for helpful information. Dr. Bailey very kindly accompanied the writer over a geological section at Currie mountain near Fredericton. He wishes especially to thank Mr. Wm. McIntosh, curator of the Natural History Museum, who accompanied Mr. Cumming to several localities and aided the writer in many ways, and Mr. Murdoch who on several occasions placed the facilities of his draughting office at Mr. Cumming's disposal. To those residents of the district who generously permitted the use of their property for camping purposes, and aided the work of the Survey in other ways, the writer also wishes to express his sincere thanks.

MONCTON MAP-AREA, NEW BRUNSWICK.

(W. J. Wright.)

Work in the Moncton map-area was resumed with the object of completing the areal geology and of examining in detail the gypsum and manganese deposits and the petroleum-bearing formations.

The areal geology was completed except in an area of about 5 square miles of the pre-Carboniferous rocks on Caledonia mountain. In this work particular attention was given to the problem of subdivision. All outcrops were located and notes made of their physical character and structure. As the work advanced it was found that the rocks fell into natural subdivisions which differed somewhat from those given by the earlier writers. But owing to the paucity of critical exposures it was impossible to fix definitely the limits of the various divisions, and to determine accurately the relation between two of the divisions.

The detailed study of the economic deposits has not been completed. The areal extent of the gypsum and anhydrite has been mapped as a unit but no time was given to the study of the gypsum itself. A telemeter survey was made of the Albert series at Rosevale, but further work and the assistance of a competent guide is necessary in order to locate the various beds of oil-shale. Permission has been obtained to examine the cores of diamond drill holes which have been made in the locality.

L. A. Gilbert acted as geological assistant and fulfilled his duties in a careful and efficient manner. Information and favours were rendered freely by Mr. Matthew Lodge and Mr. James Robertson and by the officials and employees of the Albert Manufacturing Company and the Maritime Oil-fields Company, Ltd. These favours, and the hospitality of the people in general, have assisted greatly in carrying on the work.

The only economic deposits which are being worked at present are the gypsum deposits at Hillsborough and Demoiselle creek, and the oil and gas wells at Stony creek. The gypsum quarries are working in full force and some prospecting has been done to open new bodies of gypsum. The work of the Maritime Oil-fields Company, Ltd., has been confined chiefly to cleaning and deepening some of the wells. The officials feel assured of a good supply of gas for the ensuing winter. No attempt has been made to work the oil-shale deposits, but the promoters feel confident that the work will be taken up as soon as the present financial stringency has passed.

Albert mines, and Rosevale (Baltimore) are the only localities in the Moncton map-area where attempts are being made to start the oil-shale industry. The Albert mines area was described briefly in the Summary Report for 1913. At Rosevale the Albert series occupies an east and west belt which averages about one-third of a mile in width. About 3 miles of the eastern end of this belt lies in the Moncton map-area. To the south the belt is bounded by the highlands known as the Caledonia mountains, made up of schist and igneous intrusives which unconformably underlie the Albert series. On the north and east the Albert series is overlain unconformably by gently inclined beds of coarse red conglomerate. The beds of the Albert series strike in a general east and west direction and dip north at angles averaging 15 to 30 degrees.

For many years it has been known that the Albert series in the Rosevale district contains beds of "massive" and "curly" oil-shale. The beds have been opened at various places by tunnels, and prospected by diamond drilling. Samples tested by the Mines Branch, of the Department of Mines, Ottawa, yielded from 39 to 54 imperial gallons of crude oil and 67 to 110 pounds of ammonium sulphate per ton. A 36 ton sample retorted by the Pumpherson Oil Company, Scotland, averaged 40·09 gallons of crude oil and 76·94 pounds of ammonium sulphate per ton. All of the known outcrops, tunnels, and drill-holes were located by a telemeter survey, and permission was obtained to examine the diamond drill cores, in order to determine if possible the number and extent of the oil-shale beds.

PHYSIOGRAPHY AND SURFACE GEOLOGY OF NOVA SCOTIA.

(J. W. Goldthwait.)

The three summer months of 1914 were spent in completing the study of surface features of Nova Scotia, which was begun last year. The observations of these two seasons touch many aspects of surface geology and physiography, affording, with our photographs and maps, material for a comprehensive report on the significance and origin of the scenery of the province. A bulletin covering this broad subject will be written during the winter. Among the larger topics which will be included in it are the rock foundation of Nova Scotia, the uplands and mountains, the lowlands and valleys, the rivers and lakes, the glacial features, and the coastline. Each natural feature will be considered in such a way as to show what its life history has been during the geological past. Among smaller details of popular interest which will be described and explained are Digby Gut and other gaps in North mountain, submerged forests at Amherst, Grand Pré, Yarmouth and Halifax, raised beaches at Brier island, drumlins at Chester, Yarmouth, and Halifax, the Fairy Rocks at Lake Kejimkujik, sand dunes at Port Mouton and Cape Sable, sinkholes and caverns in the gypsum districts, "boarsbacks" near Parrsboro and Sydney, and the great rocking stone near Halifax. A new map of the old fortress of Louisburg, based upon Gridley's map of 1745, will indicate how the sea has attacked the shore at this place, and how far it has cut away the ramparts during the last one hundred and seventy years. It will also show that there has been no sinking nor rising of the coast at this place during the last two centuries. The report will thus treat of the natural history of the province, so far as inorganic nature is concerned.

It is hardly necessary to say that the field work directed to the end just described has incidentally thrown light upon a number of scientific problems of interest, such as the direction of ice-sheet movement across Nova Scotia and Cape Breton, the source of this sheet of ice, recent stability or instability of the coast, etc. Certain topics of this sort will be adequately discussed in papers of a more technical character.

The field work this season began on June 15, and ended on September 18. Several days were spent, at first in and around St. John, in conference with A. O. Hayes regarding some Pleistocene features of importance in the interpretation of the surface geology of the St. John district. About three weeks were spent in work in Cape Breton including a traverse of the tableland of northern Victoria county near Aspy bay. The rest of the time was distributed rather uniformly over the peninsula of Nova Scotia, with some preference for important centres like Halifax, Truro, and Amherst, and for the more frequented summer resorts like Digby, Wolfville, Chester, and Yarmouth.

John L. Ferguson worked ably as my assistant throughout the season, preparing detailed topographic and surficial geology maps, gathering observations at localities which I did not have time to visit myself, taking photographs, etc. Co-operation was generously given us by Professor Haycock of Acadia college, by Mr. Harry Piers, Curator of the Provincial museum at Halifax, and by Mr. Donald S. McIntosh of Dalhousie University. These gentlemen accompanied me on various trips in fields with which they are familiar, and aided me in many ways in securing material of local interest and of scientific value. I am also indebted for many courtesies to Principal Sexton of the Technical School of Nova Scotia, to Mr. Knight of the Royal Engineers at Halifax, and to Mr. Charles H. Harvey of the Department of Marine and Fisheries.

The state of war in Europe made it necessary to cancel plans which had been arranged for a visit to Sable island.

While the character of the forthcoming report is not economic in the usual sense, it is hoped that it will not only have the effect of interesting the people of Nova Scotia in the wonderful scenic features of their province, but that it will attract more people from elsewhere to its vacation retreats and summer resorts.

CALEDONIA MAP-AREA, QUEENS COUNTY, NOVA SCOTIA.

(E. R. Faribault.)

The writer's field work during the season of 1914, was the continuation of the mapping of the northwestern part of Queens county, Nova Scotia. It consisted of the topographical and geological survey of the greater part of the area covered by the Caledonia map-sheet No. 107, and some of the country immediately adjoining to the south and west. The whole area is underlain by the Gold-bearing series, except two small expansions of granite coming in from the main interior batholith in the western part of the area.

Much economic importance is attached to the location and structure of the anticlinal folds and domes in the Gold-bearing series, because practically all the gold deposits of Nova Scotia are found on domes of pitching anticlines and the vein distribution on any one dome is largely dependent on its own peculiar structure. The geological structure of the rocks in the area surveyed is thus of special economic interest on account of the gold deposits worked at Whiteburn and West Caledonia and a few other prospects elsewhere.

The detailed mapping of the Gold-bearing series has now been in progress for many years, and the elaborate maps, plans, sections, and reports thus far published have proved of immediate practical advantage to the mining men, who have testified to their economic value and usefulness and have requested that this work be continued. It is another instance, lately of frequent occurrence, of geological work done from a purely scientific standpoint having direct economic value. In Memoir No. 20-E, just published and entitled the "Gold Fields of Nova Scotia," is presented a concise and comprehensive record of the results of the investigations made by the writer in these fields, as well as the views of others on the subject.

The area surveyed last season roughly forms a rectangle measuring 16 miles north and south and 19 miles east and west, the extreme limits of which comprise: eastward Brookfield and Pleasantfield on the Annapolis and Liverpool road; westward Tobeatic, Pescawess and Kejimkujik lakes; southward, First, Second, and Rossignol lakes, and northward Grafton and Harmony lakes. Much still remains to be surveyed, however, particularly in the northeastern part of the area, and more detailed examination has yet to be made of the geology and mineral occurrences of the whole area. The greater part of another season will be required to complete the field work necessary to finish the Caledonia map-area and prepare a general report.

Field work was commenced on May 4 and continued until October 21. The assistants for the season were J. McG. Cruickshank, W. P. Crowe, L. Strickland, and C. W. Knowles. Mr. Cruickshank's long experience in the Gold-bearing series was especially valuable in working out the detailed structure of the rocks, while Mr. Crowe's previous work in topographical surveys rendered his services very efficient. During the past season, S. C. McLean, of the Topographical Division of the Survey, made a transit-stadia traverse and ran levels of the county line bordering the western part of Queens from the Annapolis-Liverpool road to the Atlantic shore, and ran stadia levels along the road from the county line near Kempt to Lowe's landing on Lake Rossignol. These surveys and those previously made with transit and chain by L. N. Richard of the Survey on the Halifax and Southwestern railway and some of the main roads, will serve as control lines to tie up the surveys of that region.

Although the field work is not yet completed it may be well to record provisionally some of the results attained which may have some immediate usefulness.

With the exception of the two small expanses of granite on the west side of Kejimkujik and Pescawess lakes, the whole area is underlaid by the Gold-bearing series. This sedimentary series has a thickness of over 30,000 feet and is divided into two conformable formations: a lower one, known as the Goldenville formation, chiefly composed of thick beds of quartzite, with layers of slate, and an upper one, called the Halifax formation, essentially made up of slate. These rocks are closely folded into broad anticlines and synclines, the axes of which have a general northeast and southwest trend. As a result of the folding and subsequent erosion, the Halifax slate formation occurs in zones chiefly along the synclines, while the Goldenville quartzite formation is exposed along the anticlines. In the neighbourhood of the granite the quartzites and slates are metamorphosed into gneisses and schists.

The greatest width of the Gold-bearing series in the map-area, measured at right angle to the folding, is 21 miles from Pleasantfield to the north end of Kejimkujik lake. A traverse section between these two points gives five major anticlines and as many intervening synclines. As the gold deposits are found to occur at points of doming along the anticlinal axes of folding, the anticlines and the approximate location of the domes are here provisionally given in the order in which they occur from south to north.

(1). *Fifteenmile Brook Anticline.*—The anticline crosses the Liverpool-Annapolis road 0·3 mile south of Fifteenmile brook and, extending southwesterly, passes near the north end of George lake and crosses Liverpool river near the mouth of Kempton brook. It pitches easterly for the whole distance and comprises several minor folds along the apex. On the north limb of the farthest north of these small folds, at the base of the Halifax formation, gold-bearing veins have been worked to a limited extent at Fifteenmile Brook mines, and in one of these veins the tungsten-bearing mineral scheelite was discovered by the writer in 1912.

(2). *Malaga Anticline.*—This anticline was traced from the dome of the Malaga gold mines southwesterly across Ponhook lake, touching the north end of Big Lamouna island and the south extremity of Maplesue point, thence across Little and Big Moosehorn lakes, along the north shore of Cow Moose and Long lakes, and a short distance north of East brook to Second lake on Liverpool river, where it curves towards the south across that lake to West brook. On the south side of Second lake the fold assumes a decided pitch to the east, and a few veins have been prospected for gold on what is known as Mrs. Howe's prospect. The Malaga gold deposits are situated a short distance east of the map-area. A detailed plan and section of this important mining district have already been published.

(3). *Whiteburn Anticline.*—From the dome of the Brookfield gold mines, situated a short distance east of the map-area, this anticline runs southwesterly along Beaver brook, and crosses Medway river 2 miles below the Brookfield Village bridge; thence curving westerly across Second Christopher lake it passes three-quarters of a mile south of Whiteburn Mines, where it curves again southwesterly and runs along the north side of Carrigan lake and to the south of Lacey and Menchen lakes to Lake Rossignol. It crosses the latter lake at Sparks island, Sam point, and Southwest bay, where it curves southerly to Fifth lake. At Whiteburn it forms a broad dome on the north side of which important gold deposits have been worked successfully from 1886 until 1895, producing about 10,000 ounces of gold recovered from 7,000 tons of ore crushed. Between Southwest bay and Fifth lake, a much elongated dome is developed on which large blocks of drift quartz were observed and gold float is reported to have been discovered. The conditions on this dome seem to be particularly favourable for the occurrence of gold deposits and it is well worth the attention of the prospector. A detailed plan with two sections of the Brookfield gold district has already been published.

(4). *West Caledonia Anticline.*—The anticline enters the map-area immediately north of Harmony lake and runs southwesterly across Dowling, McGinty, and Loon lakes, thence more westerly across Hitchmaker, Second Silver, and Poplar lakes. Between Dowling and Loon lakes the fold develops into a broad dome with several undulations on the north side of which is located the West Caledonia gold district where several veins have been developed to a limited extent in the upper part of the Goldenville formation.

(5). *Grafton Lake Anticline.*—On Grafton lake the slates of the Halifax formation are plicated into a minor fold which develops southwesterly into an important anticline and syncline. The axis of the anticline runs along the south side of Kejimkujik lake, traversing Snake lake and the north end of Hemlock island, then across the middle of Cranberry, Mountain, and Big Pescawess lakes, beyond which it passes north of Back lake to the granite. The eastern part of the anticline has a decided pitch to the east and at Snake lake the Halifax slate formation is underlaid by the Goldenville quartzite formation. Farther west a dome is probably developed, but the rock structure has not yet been determined satisfactorily on account of the scarcity of the exposures and the extensive metamorphism of the rocks. The probable occurrence of the dome, above referred to, is interesting in connexion with an unconfirmed report that some very rich quartz had been obtained, several years ago, by an Indian in this locality.

The only mineral of economic value besides gold occurring in the map-area is infusorial earth (diatomaceous earth or kieselguhr). It is made up largely of silica, a variety of opal, and represents the remains of certain aquatic forms of plant life known as diatoms. A deposit of this mineral was discovered last season on Liverpool river, two-thirds mile below Loon Lake falls, or 2 miles below Kejimkujik lake. It was observed on a small island, as well as a little farther north on the left bank, where the river forms a wide stillwater. At the time of discovery the water was exceptionally low and the deposit projected only a few inches above the surface of the water. The extent and depth of the deposit could not be ascertained at the time. On the east side of the river, and as far north as the head of Loon lake, the land is flat and mostly covered with swamps and meadows over an area measuring 1½ miles by one-half mile. As the infusorial earth deposit appears to be older and underlying these vegetable and alluvial deposits, it may spread over a large part of this area. As far as could be observed, the depth is over a foot, and probably considerably more. Where observed the deposit is dead white in colour, somewhat coherent, and resembles chalk or clay. It is apparently free from vegetable and other foreign matter. Under the microscope also the mineral appears to be very pure. The deposit is situated 8½ miles west of Caledonia, the terminus of the Halifax and Southwestern railway, a good wagon road comes within 2½ miles of it, and a truck wagon road covers the rest of the distance. In order to determine the commercial value of the deposit, further investigation would have to be made regarding its extent, depth, and purity, and this could easily be done by shallow borings. The value of this product ranges from $10 to $26 per ton, according to its purity and the uses for which it is employed. On account of its physical properties it is susceptible of many industrial applications. Of late especially its uses have been considerably extended and there has been a steadily growing demand for it. It is largely used as an abrasive in the manufacture of polishing powders and scouring soaps, also as a non-conductor in packing boilers, pipes, and safes, as a fireproof building material in cements, bricks, and artificial stones, as an absorbent in artificial fertilizers and dynamite, and in the manufacture of glazings for tiles and bricks, of ultramarine and various pigments, aniline and alizarine colours, paper, sealing wax, fire-works, gutta-percha, records for talking machines, matches, solidified bromide, papier mâché, water-glass, and many other articles.

THE HORTON-WINDSOR CARBONIFEROUS AREA, NOVA SCOTIA.

(*W. A. Bell.*)

From May 21 to September 26 the writer was engaged in continuing the detailed geological study and mapping of the Carboniferous rocks in the Horton-Windsor area, Nova Scotia.

The Carboniferous rocks in this area, although they furnish fertile soils, have only minor importance as a source of workable mineral deposits. Nevertheless, their study is economically important as throwing light upon the relations of the Coal Measure rocks which occur farther east in the province. The Windsor rocks carry abundant marine fossils which permit this formation to be recognized over the whole of the Maritime Provinces, and so serve as a guide to the presence or absence of the higher coal productive strata. To make possible and easy the recognition of these rocks, wherever present, was one of the purposes of the work assigned, and the results are soon to be embodied in a final report. Accompanying conclusions of more scientific interest are to be anticipated; yet these too should aid indirectly in the study of the natural resources.

The work thus outlined was begun late in the season of 1913. During the present season it was brought practically to conclusion, although a few outlying areas had to be passed over hurriedly for lack of time. The area of study lies between longitudes of 64° 05′ and 64° 20′ west and between latitudes 44° 15′ and 44° 55′ N., and is embraced in portions of four map sheets issued by the Geological Survey, viz., Walton, Windsor, Gaspereau, and Kingsport sheets. The sheet, therefore, on which the geology will be mapped will be a special Horton-Windsor sheet.

In the work the past summer the writer was very ably assisted by G. B. Page of Lockport, Nova Scotia. Together we made the many telemeter traverses which were necessary in this largely wooded region. To several men residing in the district, the writer is grateful for particular help and encouragement. To Professor Haycock of Acadia University, Wolfville, for suggestions in problems of local geology, to Mr. Percy Reade, Avonport, Mrs. Captain TerFry, Hantsport, Mr. Alfred Lake, Brookville, and Mr. J. A. Peutz, Hantsport, for special courtesies. Lastly, he is indebted to Professor Charles Schuchert, New Haven, for helpful criticism and advice throughout the prosecution of the work.

WINDSOR AND PENNSYLVANIAN FORMATIONS IN NOVA SCOTIA.

(Jesse E. Hyde.)

The writer was engaged from the middle of June until the middle of September in an examination of the Mississippian and Pennsylvanian formations of Nova Scotia, with J. F. Logan as assistant. The Survey is indebted to Mr. Lodge, the manager of the gypsum quarries at St. Ann harbour, for material facilities afforded to the writer during the few days he was in that vicinity, and to Messrs. E. C. Hanrahan and George Ross, of Sydney, for the fullest opportunity to consult, at his convenience, publications in the library of the Nova Scotia Mining Society.

Pennsylvanian Formations at Parrsboro.

As the result of a month's work at Parrsboro, N.S., collections from the Riversdale-Union series (the beds mapped by the Survey as Devonian) and the Windsor limestone were completed. A considerable portion of the Parrsboro formation was measured in detail and extensive collections of both the plant and animal remains were obtained. The plants have since been studied and show a puzzling state of affairs.

During the past season the Parrsboro formation has been measured in part; on the shore of West bay about 1,970 feet are shown, and along the west bank of Parrsboro inlet 5,174 feet. The beds at Parrsboro inlet overlie those of West bay and there is no evidence that any of the beds in one section are duplicated in the other. Approximately 7,000 feet have been measured. The upper part of the formation is not well shown from Parrsboro north to the Cobequids and was not studied.

Fossil plants, few in species, were collected at several horizons in the 5,174 feet, examined and measured bed by bed along the west shore of Parrsboro inlet. These were submitted to Mr. W. J. Wilson, who in turn submitted them to Mr. David White for verification. Mr. White reports that the plants are undoubtedly Pottsville, probably as old as the middle or lower Pottsville, and that they can hardly be upper Pottsville, and is certain that they are older than the Fern-Ledges flora.

Since the beds which were described as unconformably underlying the Parrsboro formation are held to be of about the age of the Fern Ledges, it is obvious that knowledge of the stratigraphy of the Pennsylvanian of the Minas basin is yet in a confused state. It is proper to here point out, in order to relieve the difficulty, although not to explain the situation, that in the section on the west shore of Parrsboro inlet and at West bay—which is the type section of the Parrsboro formation and from which the plants were obtained—the Parrsboro formation is faulted against the beds that are correlated with the Riversdale-Union formations. The unconformity, which was held to be undisturbed contact, is shown on the east side of Parrsboro inlet 1½ miles distant, and from these outcrops of the supposed Parrsboro no plants have been obtained. After re-examination of this unconformity last summer to see if it could possibly be an overthrust, the writer believes that there is every indication of unconformity and no evidence of faulting at this contact, which is exposed for several hundred feet at low tide. The question now is, whether the superjacent member at the unconformity is identical with the Parrsboro formation. Its outcrops lie directly across the inlet from the type section, but the region must be re-examined before any further statement can be made.

These findings emphasize the danger of generalization at the present moment with regard to the Nova Scotian Pennsylvanian, and the necessity for thorough and careful palæontological work. In the 1912 Summary Report the writer ventured to suggest, tentatively, that the conglomerates unconformably overlying the Little River-Mispec groups east of St. John, N.B., might be correlative with the base of the Parrsboro formation. This suggestion is now withdrawn until it can be determined just what does overlie the "Riversdale-Union" on the north side of the Minas basin, for there is surely such an unconformable series.

Windsor Formation of Cape Breton Island.

After a week on the Pennsylvanian section at the Strait of Canso to complete collections at that locality, the remainder of the season was employed in the investigation of the Windsor formations of Cape Breton island from Sydney westward as far as St. Ann harbour. This work was of two kinds; it was in part exploratory to determine the general structure and relations of the Windsor in this region and to locate extensive sections for future detailed work; but for the most part it was a detailed examination of the very complete section of the upper part of the Windsor formations exposed for 4 miles along the shore of Saunder cove, Boularderie island, near Hillside post-office, and the collection of fossils from the various beds. This is the most complete single section of the marine Windsor yet known in Cape Breton island; it is 460 feet thick and shows the topmost beds of the Windsor formations. The beds are complexly folded and crushed, but the details of structure have been all worked out. The collections from this section are practically complete, except that possibly supplementary collections may be found desirable from certain beds.

The most interesting and important fact of general geological interest determined is that the Windsor formations in this section are unconformably overlain by the Millstone Grit. The Point Edward formation, which in the vicinity of Sydney lies between them, is absent at Saunder cove (although present a few miles to the southwestward). The sharp little folds and crush zones that disturb the Windsor in this section are bevelled across by the base of the Millstone Grit which shows none of these features. The folding was not on a large scale, but it was sharp. The tops of some of the anticlines must originally have been from 300 to 500 feet at least above the troughs of adjacent synclines. The areal extent of the folding is unknown and it is not yet determined whether the folding occurred between the times of formation of the Windsor and the Point Edward formation or between those of the Point Edward formation and the Millstone Grit, an important point for determination since the Point Edward formation is included in the Pennsylvanian.

This folding was accomplished either in late Mississippian or very early Pennsylvanian time or in the interval between them.

AN INVESTIGATION OF RADIO-ACTIVE MINERALS IN EASTERN CANADA.

(C. W. Robinson.)

INTRODUCTION.

The work of the season was begun on June 4 and ended September 27. Explorations were undertaken in Nova Scotia, New Brunswick, Quebec, and eastern Ontario for the purpose of investigating localities where radio-active minerals had been reported to occur, or where the conditions were apparently favourable for their occurrence. Collections for the mineralogical department of Victoria Memorial Museum were to be made, should interesting specimens be found during investigations.

METHODS OF PROCEDURE.

The writer had no regular assistant. When necessity arose, a local guide, helper, or driver was hired. In carrying on investigations, various mines or prospects where radio-active minerals had been reported, were examined. Also advantage was taken of information obtained locally concerning prospects. Localities where the geological formations or mineral associations seemed similar to those in which radio-active minerals have been found in economic quantities in other countries, were prospected. Collections made by private individuals were examined. In the field, specimens were examined for reactions with the scintilloscope, and, in the laboratory, doubtful specimens were examined and determined by R. A. A. Johnston. All information possible concerning the localities visited, and the best means of reaching them had been previously collected and systematically arranged by Mr. O. E. LeRoy.

Thanks are due to Mr. Ernest Turner of New Ross, Nova Scotia, for donations of stalactitic limonite and crystals of pyrolusite.

OCCURRENCES OF RADIO-ACTIVE MINERALS IN OTHER COUNTRIES.

The chief commercial radium-bearing minerals are carnotite, uraninite or pitchblende, and autunite. The last two of these are found associated with primary acidic, coarse-grained rocks such as coarse granite or pegmatite. The mineral pitchblende is heavy, black in colour, and of a resinous or pitchy lustre. Its associate minerals are often tin and tungsten ores as well as many sulphides, such as pyrite, chalcopyrite, galena, sphalerite, molybdenite, etc. Topaz and fluorite are also often found as associates. A very interesting and concise summary of the properties, occurrences, and associations of radium-bearing minerals is given in "Prospector's Handbook No. 1" by Mr. Wyatt Malcolm, published by the Geological Survey.

LOCALITIES VISITED.

Nova Scotia.

The first locality visited was that at New Ross, N.S. Here a broad intrusive mass of porphyritic granite was found to be cut by many acidic dykes, of various textures, which bear minerals of many varieties. Among these are sulphides such as pyrite, sphalerite, molybdenite, chalcopyrite, and bismuthinite. Cassiterite (tin stone) also is found. Some or all of these minerals have been found associated with the radium-bearing minerals of Portugal, Cornwall, or Bohemia, where the ores are of economic value.

The following prospects were examined: The Reeves property on Dalhousie Road, about a mile south of Lake Ramsay. A pit about 12 feet in depth dug here was partly filled with water. Investigations of the dump showed a coarse pegmatite, bearing huge crystals of quartz, some as much as 2 feet in length. Purple fluorite, lepidolite, pyrite, and specks of cassiterite were found as accessory minerals. No radio-active minerals were found. Similarily prospects were visited about the shores of Lake Ramsay, on the Edward Keddy property, on the Arthur Keddy property, a prospect worked by F. C. Lavers on Lake Ramsay road, the Lantz-Keddy molybdenite prospect near the west bank of the Larder river, a mine on the Ernest Turner property being worked at the time for tin ore, on the banks of the Wanabach river. Outcrops on the Wanabach, especially those near the contact with the sedimentaries, west of the tin mine, were examined, also outcrops on the Larder river and Mill brook and dykes in all outcrops that could be conveniently reached in the time at my disposal.

These New Ross deposits have been described in more detail by E. R. Faribault, H. T. Piers, R. A. A. Johnston, and W. Wright. Field and later laboratory examinations failed to reveal the presence of radio-active minerals.

Late in June a short visit was paid to the tungsten prospect situated about three-quarters of a mile north of the railway station at Waverley, Halifax county, N.S. At this locality parallel veins of quartz striking approximately east and west and ranging in thickness from 1 to 5 inches dip very steeply into the slates. Small scales of scheelite were found to line cavities in the vein mineral. No radium-bearing ores were found on careful examination with the hand lens.

Very similar results were obtained from the investigation of a tungsten prospect at Baker Settlement, about 12 miles northwest of Bridgewater, Lunenburg county, N.S., described by Mr. Faribault in Summary Report of 1911.

In July a visit was made to the scheelite mine at Scheelite, about 3 miles west of Moose river, Halifax county, N.S., and vein material in the dumps examined. No indications of radio-active minerals were observed.

New Brunswick.

During the third week of July a trip was made to the region about the mouth of Burnthill brook to examine the dykes of tin-bearing greisen and the mineralized quartz veins cutting the Cambro-Silurian slates of that locality[1]. The place was conveniently reached by poling down the southwest Miramichi from Sparkle station on the Transcontinental railway. The quartz veins there cross the river generally striking 12 degrees to 30 degrees west of north. Some of them appear to be barren, but others bear small amounts of molybdenite, wolframite, and iron pyrites. A prospect had been opened by Messrs. Lodge and Frieze on a richer vein in the side of the hill about one-quarter of a mile due south from the mouth of Burnthill brook. Specimens taken from this vein showed considerable quantities of molybdenite, wolframite, and pyrites in quartz. Topaz crystals were also found. In a dyke examined on the north bank of the river, molybdenite and cassiterite were found in the greisen. The mineral associations of this area seemed to warrant careful investigation for uranium ores. Search was made in the outcrops near and along the banks of the river and brook and at the granite contact about half a mile north of the river, and shots were put in at several points. The results were negative as far as the minerals sought were concerned.

Quebec.

Late in July, the Lievre River locality in Ottawa county, Quebec, was visited. Uranium ores had been found in small quantities in the Villeneuve mica mine. Gummite and uranophane were found as coatings on tourmaline crystals occurring in the pegmatite of the mine dump. However, the quantity of these uranium-bearing minerals is very small. M. E. Wilson, of the Geological Survey staff, is making a detail survey of the area including the mines. The Pearce "Spar" mine and a feldspar prospect opened near the Patineau property at Glen Almond were examined. The Pearce mine is described in Schmidt's report on mica mines.[1] At the Pearce mine a pegmatite dyke about 20 feet in width has been quarried. On the dump was found a pink feldspar with a strong fetid odour, muscovite, quartz, tourmaline, pyrites, and small veins of hematite.

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[1] Tin and Topaz in New Brunswick, by R. W. Brock, Canadian Mining Journal, No. 17, Sept. 1, 1911.
Topaz in New Brunswick, Ellsworth, Mineralogical Magazine, xvii, No. 78, p. 39.
Summary Report Geol. Surv., 1911, pp. 13 and 360.

A rather hurried investigation was made of the mica mines at Lake Pied de Monts, 18 miles from Murray Bay, Quebec. Two tunnels have beeen excavated horizontally, one 50 feet, the other 30 feet, into the face of the cliff and following a pegmatite dyke about 12 feet thick outcropping sheet-like high above the northern shore of the lake. Examination of the dump revealed large crystals of pink orthoclase and white microcline, with crystals of both biotite and muscovite up to 6 inches in diameter. Accessory minerals are hornblende, garnet, and ilmenite. Pits have later been sunk into the pegmatite along the north bank of a creek leading from the foot of the lake. The pits were nearly full of water. Samarskite has been found there, but a hurried search of the dump failed to disclose that mineral.

In the early part of August, an examination was made at the ilmenite mines of St. Urbain near Bay St. Paul, Quebec. These mines have been described by C. H. Warren in the American Journal of Science, Series 4, Vol. 33. Sapphirine has been found here embedded in the feldspar of the anorthosite intrusive. No good specimen of this could be obtained.

Ontario.

Later in August, work was carried on in Haggarty and adjoining townships in Renfrew county, Ontario. Careful search was made on lot 13, A, of Haggarty where a small pocket of allanite was found some years ago. A systematic and detailed search failed to reveal any more of the mineral. The biotite-granite gneiss there is cut by numerous pegmatite dykes carrying crystals of magnetite.

Lyndoch township, also in Renfrew county, was next visited. Various prospects have been opened in this locality for pyrrhotite, corundum, etc. Some specimens of columbite were taken from lot 23, XV, in a prospect opened by Messrs. Parks and Sullivan. Here flat plates of columbite, often 6 inches in diameter and about $\frac{1}{16}$ of an inch thick, are found in the reddish feldspar of the pegmatite—also in small concentric masses about the size and shape of a split hazel-nut. Other minerals of the pegmatite are a green microcline feldspar, smoky and colourless quartz, large crystals of green beryl often 6 inches in diameter, and biotite.

The accessory minerals, are: garnet, tourmaline, fluorite, and magnetite. This prospect has been described by Dr. W. G. Miller in Report of Bureau of Mines for 1897, pages 334-337.

The township of Madoc, Hasting county, Ontario, was visited in September. Here considerable mining of iron ores was carried on during the latter part of the last century. Uraconite has been reported, occurring as a yellow crystalline powder in fissures in magnetite at the Seymour mine, lot 11, V. Here two shafts about 30 feet apart had been sunk following magnetite masses. These were filled with water to within a few feet of the surface. Most of the ore had been taken away, but pieces, especially those containing sulphide, were found scattered about the dump. These were carefully examined for uraconite, a slow process in view of the quantity of yellow powder from decomposing pyrites. This examination gave negative results.

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[1] Report of Mines Branch, No. 118.

Other mines visited in Madoc township were the "Sutton," "Wallbridge," and "Miller" hematite mines in lots 13, VI, 12, VI, and 12, VII, respectively. The "Cook and Thompson" mine, lot 15, V, showed beds of magnetite bearing much calcite and pyrite, in horizontal limestone strata. Other magnetite mines visited were the "Knob," and "Hobson," also the "Nelson" pyrrhotite mine. These lie along the face of the hill to the south of the railway near Malone. The "49 Acre," "Cameron," "Farrell," and "Sixsmith" mines were examined. No radio-active minerals nor interesting specimens were found in the dumps.

Uraconite has also been reported to occur in magnetite at the "Victoria" mine, lot 20, I, of Snowdon township, Haliburton county. Mr. Stopford Brunton of the Geological Survey, visited this mine at the same time as the writer and took specimens for electroscope examination. This visit was made late in September and ended the investigations of the season.

CANADIAN ARCTIC EXPEDITION, 1914.

GEOLOGICAL RECONNAISSANCE OF THE ARCTIC COAST BETWEEN DEMARCATION POINT, AND THE MACKENZIE RIVER; WITH A SECTION INLAND UP THE FIRTH RIVER, MACKENZIE DISTRICT.

(John J. O'Neill.)

To carry on geological work it was necessary to make a base at Herschell island, which is approximately 155 miles east of the winter quarters of the expedition, at Collinson point, Alaska. The reconnaissance was carred on by means of dog-teams, and the weather conditions rendered impossible other than a general investigation. The time occupied in carrying on this survey was from February 26, when Demarcation point was reached, until April 8, the date of arrival at Shingle point at the mouth of the Mackenzie river. I am indebted to Ernest De K. Leffingwell, of Flaxman island, for a synopsis of his work on the geology of the coast and adjacent mountains west of Demarcation point; this, combined with a familiarity with the rocks gained on a hunting trip into the mountains up the Sadlerochit river, was of considerable assistance in my work east of the boundary line.

The length of coast traversed was about 130 miles, and the Firth River survey was carried 50 miles inland from the coast.

PHYSIOGRAPHY.

The coast-line parallels the mountains at a distance of approximately 15 miles. A narrow coastal plain passes abruptly into a rolling plateau which slopes gradually upward to a height of about 400 feet and terminates at the north face of the mountains.

The coastal plain is an unimportant feature, rarely exceeding half a mile in width. Along a considerable part of the coast the waves work directly on the plateau, and the coastal plain is missing. In the vicinity of the mouths of rivers bars of sand and fine gravel have been thrown up, forming long, narrow lagoons along the coast. Rarely are boulders to be seen anywhere. Thus the ocean is held in check near the rivers, but is fast destroying the intervening coast, and will ultimately, by a flank attack, force a general retreat of the coast-line.

The plateau, as well as the coastal plain, apparently occurs along the whole Arctic front, from the Mackenzie to Colville river at least; Schrader noted and described it in some detail in his section across the mountains and down the Colville, made for the Alaska Survey. He considers it a peneplain, of undetermined age, covered with a mantle of morainic and outwash materials.

The region was covered with snow at the time of the present examination, but along the cliffs, and at a number of places inland, exposures were found. The section on the Firth river showed a peneplained surface over which is spread a mantle of stratified muds, sands, and gravels. Fossils were obtained from the folded rocks below, and from the overlying loose material, so that a limiting range will be obtained for the age of erosion. At Kay point the ocean is actively eroding the plateau mantling from the eastward. At the east end of the winter portage across the point, 6 miles from its end, the mantle is seen to be over 100 feet in thickness, to be composed of materials similar to those on the Firth, and to contain chips of shells, in a layer near the base, which are apparently of the same species as those found on the Firth river. The point at this place is only about half a mile across and will in time be cut through.

The mountains rise abruptly from the plateau, making a distinct break in the topography. A sub-range faces the main chain of mountains, and is separated from it by a stream valley, only parts of which are at present occupied by rivers. The general elevation of this sub-range is about 2,000 feet.

Details of the topography and physiography of the mountains will probably appear in the report of the International Boundary survey, and they will apply to the region now under discussion. The writer was not in a position to get this data. The mountains form a great arc, convex towards the northeast, in which the Rocky mountains change their trend from northwest to west about Demarcation point, and, farther west, turn farther, acquiring a southwesterly direction.

STRATIGRAPHY.

Recent deposits are limited to the sands and gravels about the mouths of rivers; in all other places the streams and the ocean are carrying out a work of destruction. No adjustment has as yet been reached since the last elevation of the coast.

The age of the stratified sands, gravels, and muds, which mantle the plateau to a depth of over 100 feet in places, is not yet determined. Their age as well as their origin will be better understood when the fossils collected have been determined.

A general statement concerning the rock section found on the Firth river, accompanied by a table of formations, is all that can be given at present.

The lithology is very similar to that in Leffingwell's section, and to that of the Colville river, and Cape Lisburne sections, described in Prof. Paper No. 45, U.S.G.S. So closely do the sequence and character of the formations follow those of Leffingwell, that it seems highly improbable that they are not continuations of the rocks which apparently extend from Cape Lisburne eastward along the entire Arctic face of the mountains. The distance between these two most eastern sections is about 70 miles.

The whole section is composed of sedimentary rocks, including sandstone shales, conglomerates, cherts, and limestones. The overturned folding, together with minor faulting, made it very difficult to arrive at any very accurate conclusion regarding the thickness of various formations; the thickness assigned to each is a fair approximation, except in the case of the youngest rocks. These shales offer little, if any, contrast. They are repeated by folding for more than 2 miles and it is only possible to say that they are something over 100 feet in thickness. The formations are sufficiently distinct to be readily recognized in the field. One series of rocks appears at the crest of an anticline and soon becomes the prominent one of the section only to be superseded in its turn; the distance for which it is prominent depends on its thickness.

A careful search for fossils was maintained throughout the section, but none were found except in the youngest shales. The dearth of fossils may be due to the extreme deformation which has taken place in these rocks, and which has masked many of the features.

The following table gives the essential details of the section as gathered:—

Section along the Firth River, West of the International Boundary, Mackenzie District.

	Approximate thickness in feet.
Interstratified sandy muds, and gravels, with occasional thin seams of turf. In the loamy muds and gravels there are pockets of waterworn boulders, unassorted. The whole is apparently a river deposit, or was formed under flood-plain conditions. Fossils were found all the way up the cliff, except among the boulders; they are most abundant in the turfy layers. The fossils are snail shells of various sizes. Covering an eroded surface, the deposit does not present a uniform thickness; at Kay point it is over 100 feet thick	40
Unconformity.	
Grey, fissile shales, containing thin beds of sandstone, and lenses of dark chert; contains fossils in places. In places schistose and slaty, even forming micaceous schist. It breaks in plates, in small polygons, or in needles	100+?
Contact not Seen.	
Massive, rusty conglomerate	20+
Black and light grey chert, in massive beds, weathering a rusty brown.	50+
No Apparent Unconformity.	
Green schist and dark grey slates, tovether with red and brown shales; thin bedded	300±
No Apparent Unconformity.	
Grey shales and sandstones interbedded with coarse grained dark grey sandstone and conglomerate, the latter about 25 feet in thickness. The pebbles are of light and dark chert, green and black shale and schist, and a smaller number of light grey marble, and of buff coloured sandstone. Some of the sandstone pebbles are 8 inches in length and 3 inches across	100±
No Apparent Unconformity.	
A series of thin bedded, interbedded, black and grey limestones, black and grey cherts, and some sandstone. Beds are 4 to 6 inches in thickness	40±
No Apparent Unconformity.	
Medium grained, massive grey sandstone; one layer finely conglomeratic, containing pebbles of black chert	20+
Thin bedded light grey shale and quartzite, interbedded; weathering to a reddish colour	20
Black shale and rusty-weathering chert, with a red conglomerate a few inches thick, near the base	20
Interbedded light and dark grey cherts; beds 2 to 10 inches..........	75
No Apparent Unconformity.	
Massive grey quartzite	200
No Apparent Unconformity.	
Dark grey to black, coarse grained sandstone, and some black, sandy shale overlying 100 feet grey sandstone and shale. Most of the formation contains pebbles of black and grey chert, with some of black shale and limestone. The pebbles are small............	100 75–150
Contact not Seen.	
Black, massive limestone, mostly changed to marble; occurs repeated for 8 miles at least; base not observed.	

The divisions in the foregoing section are made by groups; it is not intended as a division into formations but merely a tabulation of natural groups as they appeared in the section. It may be suggested, however, that these groups bear a resemblance to those in the more western sections, where enough fossils have been found to determine their age.

STRUCTURE.

All the rocks in this section have been subjected to complex folding, and most of them at least to some degree of faulting. The section is located in the great bend of the Rocky mountains, and the rocks have yielded to stresses resolved into at least two directions. The result has been drag-folding, or folding in two directions nearly at right angles. Only a vertical section was available for study at the time, and this was naturally a handicap to obtaining definite results. The major folding has been along nearly east-west lines, and is in the nature of overturned anticlinoria, with axial planes dipping towards the south, at angles ranging between 45 and 75 degrees; the axial lines strike east and west with a dip ranging between 10 and 25 degrees towards the east in most of the cases observed, but occasionally with a dip towards the west. Minor thrust-faulting is common; cleavage is well developed in the shales; but there has apparently not been much crushing except at the sharp crests and troughs.

Igneous activity has not been a factor in this region, as no igneous rocks of any description were observed.

METAMORPHISM.

All the rocks have suffered more or less from the intense folding. The shales have been altered to slates in some cases; in others they have not reached this stage; and in one case they have become micaceous schists. The sandstones and conglomerates have in many cases become quartzites. The cherts are apparently unaltered. The limestones are mostly changed to fine-grained marble, but in one place a thin bed was observed to be changed to amphibolite.

ECONOMIC.

No mineralization was observed in any of the rocks on the Firth river, and prospectors assert that no colours were obtained in panning the river gravels. Prospectors have been at work in the gravels of the Canoe or Babbidge river, which empties into the ocean at Kay point. They assert that they found a fair prospect in the summer of 1913 and are at work again this summer in the same locality.

CONCLUSION.

It seems to be at least probable, that the same series of rocks extends along the Arctic face of the mountains from Cape Lisburne to the Firth river, becoming thinner towards the east. In that case the section under discussion ranges from Quaternary down to Carboniferous, with but few gaps.

The youngest series of rocks do not appear to be quite so intensely folded as the older ones, but they have suffered overturned folding. The forces acting have evidently been approximately east-west in direction in the major, and north-south in the direction in the minor folds overthrusting from the west. Part of the region has suffered planation since the last period of folding, and there has been a general rise of the coast line.

NOTE.—No reference is made to Herschell island, the only island along this coast, since it will be described in a report on the Mackenzie delta.

REPORT OF THE VERTEBRATE PALÆONTOLOGIST

(*Lawrence M. Lambe.*)

In the division of Vertebrate Palæontology satisfactory progress has been made in several lines of work undertaken. Much of my own time apart from that given to the direction and supervision of the division as a whole has been devoted to research work and the study and description of undescribed material. Work in the laboratory was prosecuted with vigour until the end of May when the preparators left headquarters to continue collecting in the field, and was resumed early in October at the close of field operations. Progress has been made in cataloguing collections and in museum exhibition work. In the latter sphere progress will be more effective when suitable show cases are installed in the hall of the fossil vertebrates for the public exhibition of specimens.

Field Work.

Collecting from the Belly River formation of Red Deer river, Alberta, was continued during the past year. The results attained in 1913 by the vertebrate palæontological party, under C. H. Sternberg, chief preparator and collector, in this rich reptilian formation, were most gratifying and equal success attended the field work of the past summer when the personnel of the party remained the same. In 1913, an extensive area of "bad lands" below Steveville at the mouth of Berry creek was collected from. During the past season the exposures just east of, or down stream from, the Berry Creek area were carefully gone over and included the "bad lands" of Little Sand Hill creek in addition to those of the Red Deer River valley from the mouth of this creek down to the eastern end of Dead Lodge canyon, a distance along the Red Deer of about 14 miles.

This collection of 1914, obtained through the industry and skill of Mr. Sternberg and his assistants, is a valuable and important one composed of dinosaurian material principally although other reptilian forms of the Belly River fauna are also represented.

The field party left Ottawa for Red Deer river on June 1 and returned on October 8. In all a carload of fossils from the Belly River formation was shipped east.

With the object of obtaining vertebrate remains typical of the fauna of the Judith River beds of Montana, described by Leidy and Cope, for comparison with those of the Belly River formation of Alberta, Mr. Sternberg and his son C. M. Sternberg proceeded to Judith river early in the season and spent ten days at this locality, D. B. Dowling of this survey being also there at the time studying the stratigraphy of the region. A collection typical of the vertebrates of the Montana beds was secured which will be useful for future reference.

Also it was thought advisable that Mr. Sternberg should visit the Oligocene beds of Bone coulée and vicinity at the eastern end of the Cypress hills, before returning east at the close of the season's work on Red Deer river, that he might become familiar with this particular locality prior to possible further collecting from these beds in the future. With this end in view, and accompanied by G. F. Sternberg, he proceeded, on leaving Red Deer river at the beginning of October, to the eastern end of the hills from Maple creek the nearest convenient point on the Canadian Pacific railway. Some of the principal exposures in Bone coulée were visited and a small collection of titanothere material made, but as snow fell and the weather proved inclement a day and a half only of the few days spent there could oe turned to account for collecting.

Last summer's collection from the Red Deer includes two ceratopsian skulls which are remarkable for their completeness as well as their good state of preservation. These skulls are of *Chasmosaurus belli* and *Centrosaurus apertus*, and in both the mandible is in place, a feature which greatly enhances their value both as study and exhibition specimens. In Centrosaurus the lower jaw had not previously been found in position; the Chasmosaurus skull is entire and in all respects is the most complete skull of this particular, if not of any ceratopsian so far discovered. Another specimen of great interest discovered last summer is the "club" or greatly enlarged bony covering of the end of the tail, with the distal caudal vertebræ in place, of an armoured or plated dinosaur which may prove to be distinct from the partially known Belly River *Euoplocephalus tutus* of which the cranium and massive neck scutes were described by the writer in 1902.

The wonderful diversity of the dinosaurian fauna of the Belly River formation is well exemplified by the collections from Red Deer river now in possession of the Geological Survey. The horned dinosaurs (Ceratopsia) in particular are well represented.

To date, the better known forms from this horizon on Red Deer river are:—

Theropoda: carnivorous dinosaurs.
Gorgosaurus libratus Lambe, 1914.
Ornithomimus altus Lambe, 1902.

Orthopoda:
Plated or armoured dinosaurs.
Euoplocephalus tutus Lambe, 1902.
Horned dinosaurs.
Eoceratops canadensis Lambe, 1902 (gen. nov.)
Centrosaurus apertus Lambe, 1904 (synonym *Monoclonius flexus* Brown, 1914.)
Styracosaurus albertensis Lambe, 1913.
Brachyceratops dawson (Lambe), 1902.
Chasmosaurus belli Lambe, 1902.

Trachodonts:
Stephanosaurus marginatus Lambe, 1902 (synonym *Corythosaurus casaurius* Brown, 1914.)
Gryposaurus notabilis Lambe, 1913.

Research and Office Work.

A large proportion of my time has been given to the study of the collection of 1913 from the Belly River formation of Red Deer river, more particularly to the new generic forms of trachodonts and horned dinosaurs represented therein. Collections and specimens received through officers of the Survey or from individuals seeking information have been reported on as in the past.

As the result of the study of newly acquired material principally of the collection of 1913, the following preliminary illustrated and descriptive reports were published during the year:—

"On the fore-limb of a carnivorous dinosaur from the Belly River formation of Alberta, and a new genus of Ceratopsia from the same horizon with remarks on the integument of some Cretaceous herbivorous dinosaurs." Ottawa Naturalist, January.

"On Gryposaurus notabilis, a new genus and species of trachodont dinosaur from the Belly River formation of Alberta, with a description of the skull of Chasmosaurus belli." Ottawa Naturalist, February.

"On a new genus and species of carnivorous dinosaur from the Belly River formation of Alberta, with a description of the skull of Stephanosaurus marginatus from the same horizon." Ottawa Naturalist, April.

"On new species of Aspideretes from the Belly River formation of Alberta, with further information regarding the structure of the carapace of Boremys pulchra." Trans. Royal Society of Canada, June.

Also a paper entitled—

"Description of a new species of Platysomus from the neighbourhood of Banff, Alberta." Trans. Royal Society of Canada, June.

A card catalogue intended to include a list of all fossil vertebrates in the possession of the Geological Survey is now being made. Prior to the removal of the collections from Sussex street to the present building the then exhibited vertebrates were catalogued, but further cataloguing has not since been possible until this year.

Mr. R. Weber, a skilled palæontological artist of many years experience, was employed for about three months in the autumn in making shaded line drawings principally of the complete carnivorous dinosaur skeleton and other specimens belonging to the Red Deer River collection of 1913. These drawings are intended to illustrate the first of a series of memoirs which it is proposed to publish as time permits, on the various groups of Cretaceous dinosaurs. In these publications will be embodied further knowledge of these reptiles now being acquired from Red Deer River collections.

Public Exhibits.

In the hall of fossil vertebrates improvements have been effected in the labelling, mounting, and arranging of the specimens. The exhibit is a source of great attraction to the general public and is rapidly growing in scientific interest and value. It is still of a temporary nature and must be regarded as such until show-cases are available for its proper display.

Additions have been made to the exhibit during the year, of which the following may be mentioned:—

A new and very large species of ganoid fish of the genus Platysomus from rocks of supposed Permian age near Banff, Alberta.

The skulls of three new generic forms of Cretaceous dinosaurs belonging to the collection of 1913 from the Belly River formation, Red Deer river, Alberta. These skulls are of the plant eaters Gryposaurus (the high-nosed dinosaur) and Stephanosaurus (the hooded dinosaur) and of the flesh eater Gorgosaurus respectively, of which latter the complete skeleton, about 29 feet long from the snout to the tip of the tail, was discovered in 1913, and will soon be ready for exhibition. These remains of the immense dinosaurs of the Cretaceous of the west on account of their great size and good state of preservation constitute a unique feature of the exhibit.

An interesting collection of skulls and jaws of mammals from the Oligocene of Wyoming illustrating the life of the period. It includes a number of well-preserved skulls of oreodonts, a large skull of Elotherium, and other forms, horses, rhinoceroses, rodents, and sabre-tooth cats, represented principally by jaws holding teeth.

A well-mounted skeleton of a bull bison from the herd at Wainwright, Alberta, was placed in the museum hall and is most instructive in comparison with the fine series of heads of the Pleistocene species from Yukon.

The skeleton of the large Cretaceous fish *Portheus molossus* has been placed permanently on the west wall of the hall where it can now be seen to advantage.

Laboratory.

The machinery and general equipment installed in the palæontological laboratory in 1912 has enabled Mr. Sternberg and his assistants to prepare and mount rapidly and in a most satisfactory manner the exhibits to which reference has already been made as having been placed in the hall of fossil vertebrates during the year. Other vertebrate material intended mainly for purposes of study and comparison and not necessarily for exhibition has also been prepared. The skill and patience necessary in freeing vertebrate fossils from the surrounding matrix, in mending and strengthening them before they can be handled preparatory to being finally mounted is of a high order not always fully appreciated by the public in viewing the final result in a museum hall.

Work on a number of specimens of the 1912 collection begun in the first half of the past year and requiring some months of preparation, was continued after the season in the field. Of these the complete skeleton of the carnivorous dinosaur *Gorgosaurus*, 29 feet in length, is one on which much labour must be expended.

Additions to the Vertebrate Palæontological Collections During 1914.

Collected by Officers of the Geological Survey.

Sternberg, Charles H. and party.—

A large collection of dinosaurian and other reptilian remains from the Belly River formation, Red Deer river, Alberta, in the vicinity of and above Dead Lodge canyon. Access. No. 77.

As this collection did not reach Ottawa until October and as many of the specimens are yet in the condition in which they were brought from the field, tentative determinations only are possible at the present time.

This important collection contains the following:—

(1). The massive, armoured, expanded distal end or "club" of the tail of a stegosaurian dinosaur. At the proximal end of the specimen and passing backward into it are vertebræ sheathed in longitudinally placed ossified tendons. The enlarged bony covering is 18 inches broad, 8¾ inches high, and 20¾ inches long.

Also parts of the armoured caudal end of three other individuals.

(2). Two skulls of trachodont dinosaurs.

(3). The skull, including the mandible, of *Chasmosaurus belli* Lambe, with the greater part of the remainder of the skeleton. Length of skull about 60 inches.

(4). Thirty caudal vertebræ, in place, of a ceratopsian (horned) dinosaur.

(5). Complete limbs (fore and hind) of a trachodont dinosaur, with ribs, and part of the vertebral column.

(6). Most of the skeleton, exclusive of the head and tail, of a trachodont, thought to be referable to *Gryposaurus notabilis* Lambe.

(7). A skull, with some ribs and limb bones, referable probably to the rhynchocephalian reptile Champsosaurus.

(8). The head and greater part of the skeleton of a stegosaur (plated or armoured dinosaur) which may prove to be the form having the massive caudal termination.

(9). Skull, complete with mandible, of *Centrosaurus apertus* Lambe. Length of specimen, 58 inches.

(10). Complete hind legs, pelvic girdle and tail with skin impression, of a trachodont. This specimen has a footed ischium.

(11). An almost complete skull (carapace and plastron) of the very large turtle Basilemys.

(12). The nearly complete hind limbs of a carnivorous dinosaur, with part of the pelvic girdle and head.

(13). Some hundreds of bones, found separately, representative of the large and varied vertebrate fauna of the Belly River formation.

Sternberg, C. H. and Sternberg, C. M.—

A small collection of vertebrate remains from the Judith River Cretaceous, Missouri river, Montana, U.S.A.

1. From Taffy creek at the head of Dog creek.
    - (*a*) From Bear Paw shales.
        - Mandible and 15 feet of the vertebral column of a Mosasaur.
        - A few vertebræ of a plesiosaur.
    - (b) From Judith River beds.
        - *Myledaphus bipartitus* Cope.
        - Scales of Lepidosteus.
        - Fragments of shell of turtles.
        - Vertebræ of Champsosaurus.
        - *Troödon* cfr. *formosus* Leidy.
        - Teeth of crocodile.
        - Trachodont: footed ischium and part of ilium and pubis.
        - Trachodont: scapula and metatarsal.
        - Teeth cfr. Palæoscincus, etc.
    - (*c*) From Claggett shales.
        - *Myledaphus bipartitus* Cope.

Sternberg, C. H. and Sternberg, G. F.—

A few remains of titanotheres (mandible with teeth, separate vertebræ, teeth, etc.) from the Oliogocene beds in Bone coulée, eastern end of Cypress hills, Saskatchewan.

Williams, M. Y., Ottawa.—

A minutely sculptured plate of an undetermined Arthrodire from quarry (20 feet above the base west side) at Amherstburg, Ont. Onondago formation (Corniferous limestone).

MacLean, Alex., Ottawa.—

The anterior half of a teleostean fish preserved in soft, grey, calcareous shale from a rock-slide on Pembina river, Manitoba, in the southwest corner of sec. 8, tp. 1, range 8, Niobrara Cretaceous. Separate cycloid scales are also preserved, one with the fish and one on each of two other shale fragments. Access. No. 78.

Hyde, Prof. J. E., Queen's University, Kingston, Ont.—

Natural casts ("negatives") four in number, of amphibian footprints from shore of West bay, near Partridge island, Parrsboro, N.S. Riversdale-Union formation. Access No. 80.

Presented.

Haycock, Prof. E., Acadia university, Wolfville, N.S.—

Fish remains preserved in five pieces of light greenish-grey siliceous limestone of ?Triassic age from Broad cove, near Scott bay, Kings county, N.S. Collected by Professor Haycock in the summer of 1913. These remains are determined as *Semionotus* cfr. *fultus* (J. H. Redfield) known from the Triassic of Massachusetts, Connecticut and New Jersey, U.S.A. Access. No. 79.

Hewitt, D. C. Gordon, F.R.S.C., Central Experimental Farm, Ottawa.—

A specimen of *Palæospondylus gunni,* from the lower Old Red sandstone of Achanarras, Caithness, Scotland. Access. No. 82.

Drury, Edmund Hazen, C.E., Ottawa.—

A carapace of an armadillo (?Eutatus) from the ?Pleistocene of Chili. From a railway cutting through sand impregnated with nitrate of soda, at an elevation of 3,000 feet above the Pacific ocean, on the Longitudinal railway of Chili, near Pueblo Hundido (sunken town), 50 miles east of Chanaral. Found in April, 1913. Donated by Mr. Drury, engineer in charge, Longitudinal railway of Chili. Access. No. 85.

Sanson, N. B., Curator of the Rocky Mountain Park Museum, Banff, Alberta.—

Specimen of *Platysomus canadensis* Lambe, collected by E. W. Peyto, of Banff, in 1912, from rocks of ?Permian age near Banff. The fish is preserved in two halves, having split longitudinally, along a bedding plane, between the scales of either side, exposing them from the inside. The right side of the fish was presented to the Geological Survey, the other half is in the Banff Park museum.

Purchased.

Dermal armature, mandibles, etc., of Dinichthys and allied genera from the Ohio shale (Devonian) of northern Ohio. (Collection of P. A. Bungart, Lorain, Ohio, U.S.A.) The specimens include the head of *Dinichthys terrelli* and a small cranium of *D. curtus?*. Other genera and species represented are *Dinichthys lincolni, D. intermedius, Titanichthys*, sp., *Glyptaspis* sp., and *Mylostoma*, sp.

Also two teeth of the selachian genus *Orodus*. As this collection has not yet been studied the determinations as to genus and species are tentative only. Access. No. 83.

Exchanged.

Lantern slides. Exchange. Dr. C. W. Gilmore, Smithsonian Institution, U.S. National Museum. Access. No. 84.

One slide of *Stegosaurus stenops* Marsh, skeleton of type of; collected by M. P. Felch in 1884, in the Morrison beds of the Jurassic near Canon city, Colorado, U.S.A. The specimen is shown in the exact position in which it was found in the field.

One slide of *Triceratops prorsus* Marsh. A composite skeleton based upon specimens collected by J. B. Hatcher from the Lance formation in Converse county, Wyoming, U.S.A., in 1890 and 1891. (See U. S. Geological Survey, Monograph on the Ceratopsia, by J. B. Hatcher, 1907, pp. 189-192, pl. XLIX.)

Loomis, Dr. Frederick B., Amherst College, Amherst, Mass., U.S.A.—

A series of the principal parts of the skeleton (exclusive of the femur) of *Stenomylus hitchcocki* Loomis, from the lower Miocene of Nebraska, U.S.A.

And the following species of vertebrates, represented principally by teeth, from the Patagonian beds (? upper Eocene) of Patagonia. Amherst College Patagonian Expedition of 1911. Access. No. 81.

Ancylopoda—
- *Leontinia gaudryi.* Part of the maxilla with teeth. (Amherst Coll. Cat. No. 3276b.)
- *Leontinia.* Lower jaw with teeth. (Amherst Coll. Cat. No. 3281.)

Typotheria—
- *Prosotherium garzoni.* Part of lower jaw with teeth. (Amherst Coll. Cat. No. 3077.)
- *Prosotherium triangulidens.* The cranium with cheek teeth, and parts of limb bones. (Amherst Coll. Cat. No. 3348.)

Toxodontia.
- *Rhynchippus equinus.* Part of lower jaw with teeth. (Amherst Coll. Cat. No. 3294.)

Rodentia.
- *Cephalomys plexus.* Lower tooth. (Amherst Coll. Cat. No. 3072.) Three lower teeth. (Amherst Coll. Cat. No. 3114.)
- *Cephalomys archidens.* Upper and lower teeth. (Amherst Coll. Cat. Nos. 3093, 3098, 3157, and 3159.)

REPORT OF THE STRATIGRAPHICAL PALÆONTOLOGIST.

(E. M. Kindle.)

Field Work.

Field work has been carried on in parts of Ontario, Quebec, and Nova Scotia. Early in the season a short trip was made to the Ontario peninsula for the purpose of examining the field evidence regarding the horizon at which the Devono-Silurian boundary should be drawn on the geological maps of that region which have been in preparation by Messrs. Stauffer and Williams. The latter part of the season was spent in Nova Scotia where several weeks were devoted to a detailed study of the stratigraphic relations of the Devonian to the older rocks of the region. A number of sections across the Devonian and associated beds in the area between Kentville and Bear river were studied and a large collection of fossil was made. The results of this work are in course of elaboration.

In prosecuting investigations in stratigraphic palæontology the need of a more fundamental knowledge of the physical factors involved in the problems than can be obtained from a study of the rocks alone is constantly felt. Instead of attempting, as is generally done, to infer from a study of the physical features of rocks the physical conditions under which their contained faunas lived, it has seemed to me more profitable to devote considerable time and study to the processes of rock formation now in operation. After a sufficiently large body of carefully recorded and systematically studied data relating to the physical and biological agencies now concerned in the formation of rocks has been acquired it will be possible to make many dependable deductions and inferences regarding the history of fossil faunas where now only guesses are possible. With the object of contributing to such knowledge I spent a portion of the field season in the study of sedimentation in Lakes Erie and Ontario and in the Bay of Fundy. Some of the subsidiary problems which were taken up in connexion with the general problem of sedimentation are as follows:—

1. The agencies involved in the transportation sediments.
2. Depth at which waves act effectively on the bottom.
3. Physical features of the intertidal zone.
4. Rate of deposition on tidal flats.
5. Relation of the amplitude or magnitude of ripple-marks to depth.
6. Differences between wind-made and water-made ripple-marks.
7. Influence of turbidity, depth, and other environmental factors on faunas.

Many important data relating to these various features of sedimentation have been secured which will be brought together in a report on that subject. Some attention has also been given to the dune region along the north shores of Lakes Ontario and Erie. The observations on the dunes were made from the standpoint of their relation to the general subject of continental deposition.

An attempt by L. D. Burling and myself to prepare for the Museum some cross sections illustrating graphically the geology of the Ottawa district gave a clue to some hitherto unrecognized structural relations between the Palæozoic rocks of the Ottawa valley and the crystalline rocks of the Canadian shield. It became necessary in connexion with this problem for me to spend some time in the field studying the structural relations of these two rock series in Quebec. A detailed discussion of the new interpretation of the structural relations existing between these rocks, has been prepared by Mr. Burling and myself which will be published elsewhere in the reports of the Survey. In connexion with the field work outlined above I have had the assistance of E. J. Whittaker throughout the field season which began the last week in April and ended late in September.

Office Work.

A considerable part of the office work of Mr. Burling and myself has been devoted to the preparation of reports on fossils for various members of the staff. Many other short reports on fossils sent to the Survey from various parts of the country have also been prepared. A considerable number of Silurian fossils have been determined by M. Y. Williams in connexion with his work on the Silurian of the Ontario peninsula. Mr. Burling has remained in the office during the summer in order to complete the office work on the large collection of Cambrian fossils collected by him the preceding season along the Yukon-Alaskan boundary. He has also directed during the summer the unpacking of the old collections of fossils which have been acquired through the work of the field geologists during a long series of years. W. S. Dyer was occupied with this work during the summer and since his resignation the work has been continued by W. Cross. Much of the time of Miss A. E. Wilson has been occupied in preparing a card index to these collections as they were opened and stored according to a systematic scheme. Several thousand localities are represented by these collections. The need of referring to particular lots of the old collections, which frequently arises, has made the systematic storing and cataloguing of these collections an urgent necessity.

I have been able to borrow from the U.S. Geol. Survey, through the courtesy of Dr. T. W. Stanton, parts of the card catalogue of the Palæozoic Fossils of North America belonging to that Survey, which is being copied for the use of the Palæontologists of this Survey. A considerable portion of the time of a typist has been occupied with this work, which is still unfinished, during the past winter.

Mr. Whittaker has in addition to regular preparatory work made a series of plaster casts from moulds representing most of the types of ripple-marks and other wave and current phenomena which characterize near shore deposits of sediments. This unique collection will be installed in the exhibits of the museum.

Miss Wilson has assisted in general museum work including the cataloguing of incoming collections of fossils and has rendered important aid in editing certain referred manuscript.

The office work which has reached a stage permitting publication during the year is indicated in the following list of papers by members of the division:

Kindle, Edward M.—

The Silurian and Devonian section of western Manitoba: Sum. Rep., Can. Geol. Surv., Dept. of Mines, 1912 (1914), pp. 247-261.

Notes on the Oriskany sandstone and the Ohio shale of the Ontario peninsula: Sum. Rep., Can. Geol. Surv., Dept. of Mines 1912 (1914), pp. 286-290.

Origin of "Batrachoides the Antiquor": Geol. Mag. n.s., Decade VI, Vol. I, pp. 158-61, April, 1914.

A comparison of the Cambrian and Ordovician ripple-marks found at Ottawa, Canada: Jour. Geol. Vol. XXII, No. 7, Oct.-Nov., pp. 703-713, 1914.

What does the Medina sandstone of the Niagara section include? Science, N.S., Vol. XXXIX, No. 1016, pp. 915-918, June 19, 1914.

Columnar structure in limestone; Can. Geol. Surv., Museum Bull. No. 2, pp. 35-44, pls. II-III, 1914.

General guide to the collections of invertebrate fossils: Museum of the Geological Survey, Canada, pp. 1-3, pl. I.

Burling, L. D.—

Lower Palæozoic section of the Alaska-Yukon boundary: Bull. Geol. Soc. America, Vol. 25, 1914 (Mar. 30), p. 137.

Early Cambrian stratigraphy in the North American Cordillera, with discussion of Albertella and related faunas: Geol. Survey, Canada, Museum Bull. No. 2, part VI, July 6, 1914, pp. 93-129.

Fossils of the Rocky Mountains Park: Handbook of the Rocky Mountains Park Museum. Department of the Interior, Canada. Government printing office, 1914, pp. 102-104.

The popularization of palæontology: Proc. American Assoc. Museums, Vol. VIII, 1914, pp. 92-97.

Cambrian and related Ordovician Brachiopoda—a study of their enclosing sediments: Bull. Geol. Soc. America, Vol. 25, September 15, 1914, pp. 421-434.

Wilson, A. E.—

A preliminary study of the variations of Parastrophia hemiplicata, Hall: Can. Geol. Surv., Mus. Bull. No. 2, pp. 131-140, pl. IV, 1914.

Report on Fossils.

The reports prepared by the palæontologists of the Survey for members of the staff will be found in the papers of the various geologists for whom they were prepared. Only certain collections of special interest which have been transmitted to the Survey by persons not attached to its staff will be mentioned here. One of these is a collection including an excellent lot of Devonian fossils from the Ramparts of the Mackenzie river, and a small collection of Cretaceous fossils from the Mackenzie River valley made by Dr. T. O. Bosworth of Great Britain. This collection, together with an important collection of Devonian fossils from the shore of Great Slave lake, obtained by Charles Camsell, of the geological staff, will be made the basis of a paper on the Devonian faunas of the Mackenzie River valley.

Another collection made by Mr. H. W. Jones, and transmitted by Mr. Camsell, is represented by a single coral of Devonian age. It is of special interest because it represents a hitherto unknown area of Palæozoic rocks and the most northerly locality known for the Devonian in Canada outside the Arctic archipelago.

Two specimens of *Trigonia* from the Nass formation, which were sent to the Survey by Mr. Louis Watkins from a locality near Long lake, Portland Canal district, British Columbia, have considerable interest since practically nothing has been known concerning the fossil faunas of the region represented. Dr. T. W. Stanton who has kindly examined the specimens at my request, writes as follows regarding them:—

" I have your letter of January 11 and the accompanying specimens of *Trigonia* collected by Mr. Louis Watkins in the Nass formation near Long lake, in Cascade Creek valley north of Stewart, Portland Canal district, British Columbia

The specimens all belong to a single undescribed species of *Trigonia* which I have not seen in any of our collections from the West coast or elsewhere. It belongs to the Undulatae group of Trigonia which is a group apparently confined to the Jurassic. My opinion is that the present species is from the Jurassic, and probably from the Middle Jurassic."

A collection from the deep well at Moosejaw, Saskatchewan, which was transmitted to me by Mr. E. D. Ingall was also referred to Dr. Stanton who recognized a Jurassic horizon from the lower beds. His report follows:—

" I have examined your fossils from the deep well at Moosejaw, Sask., and was somewhat surprised on taking a second and more thorough look at them to find that those from near the bottom of the well are of Jurassic age and apparently belong to the fauna which is well developed in the Sundance formation of the Black hills. The only Cretaceous fossils recognized are in a single fragment which is labelled 500? feet. The complete log of this well would be very interesting and if it is available I hope that you will see that it is published. The forms recognized in the separate samples are as follows:—

Fossils from Deep Well at Moosejaw, Sask.

Depth 500? feet:

Avicula nebrascana E. and S.
Scaphites sp. fragment of a large specimen possibly belonging to *S. nodosus* Owen
Pierre fauna.

Depth 2,750-60 feet:

Nothing determined.

Depth 3,000, 3,010:

Fragments of *Ostrea* or *Gryphaea.*

Depth 3,050 feet:

Ostrea sp.
Gryphaea calceolavar nebrascensis M. and H.
Astarte sp.
Belemnites sp.

Jurassic.

Depth 3,060 feet:

Fragments of *Ostrea, Gryphaea,* and *Belemnites.*
Astarte sp.

Jurassic.

Depth 3,075-80 feet:

Fragments of *Gryphaea* and undetermined pelecypod.

Jurassic.

Depth 3,090-95 feet:

Undetermined pelecypod—possibly a Lima.

Depth 3,100-3, 105 feet:

Belemnites sp.

Jurassic.

Depth 3,108-3,110 feet:

Undetermined gastropod and *Dentalium?*

Jurassic.

Depth. 3,120-3,125 feet:

Protocardia? sp.

Jurassic.

The nearest locality in Canada at which Jurassic rocks appear at the surface is more than 350 miles west of Moosejaw. The fossils from this well furnish the first evidence which has been obtained of the presence of the Jurassic in Canada east of the Rocky mountains and illustrate the important geologic data which the materials from deep wells sometimes yield.

Additions to the Invertebrate Palæontological Collections During 1914.

Collected by Officers of the Geological Survey.

Allan, J. A.—

Material from Banff Park, Alberta. Access. No. 249.

Brock, R. W.—

A gasteropod from the Pleistocene of Bermuda Islands. Access. No. 163.

Burling, L. D.—

Lower Cambrian material from St. Albans, Vermont. Access. No. 203.

Ordovician fossils from Beauharnois, Montreal, Pointe Claire, and Ste. Anne de Bellevue, Que., also from the vicinity of Ottawa. Access. No. 233.

Burling, L. D. and Harvie, R.—

Material from Olenoides zone and Olenellus zone from west of Georgia, Vermont. Access. No. 204.

Cairnes, D. D.—

Pleistocene Cretaceous and Palæozoic fossils from Kluane Lake district, Yukon Territory. Access. No. 214.

Camsell, C.—

A collection from Great Slave lake and Athabaska river, midway between Fort McKay and McMurray, west bank of river. Access. No. 207.

Dowling, D. B.—

A small collection of fossils from the Judith River beds of Montana, U.S.A. Access. No. 198.

Foerste, A. F.—

A collection of Ordovician fossils from Nicolet river and western Quebec and from Manitoulin islands and the neighbouring mainland. Access. No. 234.

Harvie, R.—

Lorraine fossils from Ste. Hyacinthe; Lorraine material from southwest bank Yamaska river 700 yards northwest of ferry to Ste. Hugues; a collection from vicinity of Cowansville including material from locations XLIV, LI, XLIX, of Ells Rep. No. 578, Montreal sheet; some algæ from Lower Cambrian east of St. Albans, Vermont. Access. No. 212.

Several pieces of Utica shale from the east bank of the Rideau river, Cummings bridge, Ottawa. Access. No. 251.

Hayes, A. O.—

Fossils from the Carboniferous and Pleistocene from the vicinity of Red Head, St. John, N.B. Access. No. 217.

Hyde, J. E.—

Cambrian material from Young point, Georges river, N.S. Access. No. 228.

Johnston, W. A.—

Several lots of fossils from the Lowville, Black River, and Trenton limestones of the Lake Simcoe district, a collection of Pleistocene fossils from Fort Frances and east of Isterwood, also from Ordovician calcareous drift of Rainy River district and limestone slabs with ripple-marks and sun cracks. Access. No. 208.

Keele, J.—

Small collection of Pleistocene shells from Ontario, from Chatham, Crediton, Kincardine, Port Elgin, and Thedford. Access. No. 215

Kindle, E. M.—

Fossils from Paquette rapids, Ottawa river. Access. No. 210.

A collection of material from Amherstburg, Ingersoll, and other points in Ontario peninsula. Access. No. 209.

Carboniferous fossils and sandstone ripple-marks from the Joggins, N.S. Access. No. 235.

Moulds of ripple-marks on sand from Sorel, Que. Access. No. 236.

Ripple-mark moulds, from Kingsport, N.S. Access. No. 237.

A collection of Devonian fossils from Bear river, N.S. Access No. 238.

Devonian fossils from the Nictaux region, N.S. Access. No. 239.

Moulds of ripple-marks on sand from Windsor, N.S. Access No. 240.

A collection of Devonian fossils and moulds from ripple-marks on sand from Port Colborne, Ont. Access. No. 241.

Moulds from ripple-marks on sand from Wellington, Ont. Access. No. 242.

Kindle, E. M. and Hibbard, R. R.—

A collection of fossils from 18 Mile creek, N.Y. Access. No. 226.

MacKenzie, J. D.—

Small collection of fossils and fossiliferous rock from Tchowum point, B.C. No. 23, p. 36½, 1. 1. Access. No. 196.

Fossils from the Devono-Carboniferous and Tertiary of Flathead district, Kootenay, B.C. Access. No. 218.

3 pieces of fossiliferous rock from Queen Charlotte islands. Access. No. 216.

MacLean, A.—

A few gasteropods from Stonewall, Manitoba. Access. No. 166.

McLearn, F. H.—

A collection of material from Artesian well cores from the vicinity of Winnipeg, Manitoba. Access. No. 227.

McLearn, F. H. and Stewart, J. S.—

A large collection of material from Livingstone river, or north fork of Oldman river, Alberta. Access. No. 228.

O'Neill, J. J.—

A collection of fossils from Black mountain, Mackenzie River delta, and from Herschell island. Access. No. 201.

A collection of fossils from Herschell island and the mainland. Access. No. 230.

Schofield, S. J.—

Material from a section extending from Cambrian to Devonian from Canal flats, upper Columbia lakes, B.C. Access. No. 224.

Slipper, S. E.—

Small collection of fossils from Black Diamond oil well and vicinity, Alberta. Access. No. 160.

Fossils from sandy layer in Bearpaw shales, sec. 7, tp. 20, range 2, W. 5th mer., upstream on small creek flowing into the south branch of Sheep creek from Turner valley. Access. No. 187.

Cephalopod from Claggett-Benton shales, sec. 23, tp. 19, range 1, W. 5th mer., south branch Sheep river. Access No. 187.

Unios from calcareous bed, Edmonton sandstones, SW. corner of sec. 8, tp. 20, range 2, W. 5th mer. Access. No. 187.

Stauffer, C. R.—

Fossils from Western peninsula, Ontario, from Oriskany, Onondaga, and Silurian formations. Access No. 192.

Sternberg, C. H.—

A small collection of Niobrara fossils from Logan county, Kansas, U.S.A. Access. No. 220.

Ammonites and baculites from Dead Lodge canyon, ammonites from Judith River mountain and baculites from 2 miles southeast of Judith P.O., Alberta. Access. No. 219.

Two pieces of baculites from the Bearpaw formation from the top of benches south of Nelson's ranch, Missouri river, north of Two Calf creek. Access. No. 197.

Tanton, T. L.—

A collection of fossils from Wawa river, 10 miles below Ardee river. Access. No. 206.

Wallace, R. C.—

A collection of Devonian and Silurian fossils from Manitoba. Access. No. 221.

Whittaker, E. J.—

A collection of Devonian fossils from Hagersville, Ont. Access. No. 243.

Williams, M. Y.—

Devonian and Silurian material from western Ontario peninsula and Bruce peninsula. Access. No. 244.

Silurian material from Niagara peninsula. Access. No. 244.

Silurian material from Lake Timiskaming, Ont. Access. No. 245.

Silurian material from the vicinity of Milwaukee, Wis., and from Joliet, Ill. Access. No. 246.

Acquired by Presentation.

Allen, R. C., State Geologist, Ann Arbor, Mich.—

A small collection of fossils from Limestone mountain. Horizon Niagaran and Ordovician. Access. No. 186.

Andrews, Dr. W. W.—

Small collection of Cretaceous fossils from south bank Saskatchewan river near Canadian Pacific Railway station, Morse, near Log Valley ferry. Access. No. 213.

Bosworth, Dr. T. O.—

A collection of Devonian and Cretaceous fossils from Mackenzie river, N.W.T. Access. No. 248.

Brooke, R. A., Castor, Alberta.—

An ammonite, from the Pierre shale, at Beaver Dam creek, sec. 31, tp. 38, range 12, W. 4th mer., 4 specimens from Edmonton formation, sec. 32, tp. 38, range 13, W. 4th mer. Access. No. 200.

Burpee, Lawrence J., Ottawa.—

Two pieces of fossil coral from an elevation of 7,500 feet, from the mountain above Sulphur creek, Jasper Park, B.C.

Clarke, John M., N.Y. State Mus., Albany.—

Some specimens of *Hydnoceras bathense* Hall and Clarke—from Chemung sandstone (Upper Dev.), Bath, N.Y. Access. No. 211.

Darraugh, W. J., Phoenix, B.C.—

A piece of fossiliferous rock with crinoid stems from Phoenix, B.C. Access. No. 165.

Eastwood, J., Prince Albert, Sask.—

A specimen of marl containing fossils. Access. No. 190.

English, Arthur, New Brunswick.—

A piece of fossiliferous rock from Silurian beds on Nelson river, Hudson bay. Access. No. 193.

Foerste, A. F., Dayton, Ohio.—

A collection of Richmond and Lorraine fossils from Ohio, Kentucky, and Indiana, U.S.A. Access. No. 170.

Galletly, J. S.—

A collection of Palæozoic fossils from Woody lake, Hudson Bay railway. Access. No. 229.

Gray, W. J., Vancouver, B.C.—

A couple of pieces of fossiliferous Post Pliocene clay from Roberts creek, Straits of Georgia, midway between Seechelt inlet and Gibsons Landing, B.C. Access. No. 231.

Hewitt, Dr. C. Gordon, Ottawa.—

Two pieces of Ordovician trilobites from the eastern coast of Scotland.

Hildreth, C. A., Moosejaw, Sask.—

A collection of Cretaceous fossils from the Moosejaw city well, drilling operated by Wallace Bell Drilling Co. Access. No. 185.

McLenham, John A., Edmonton, Alberta.

Several pieces of fossiliferous rock from Upper Blindman River valley, 30 miles west of Pawoka, Alberta. Access. No. 202.

McRae, C. D., Vancouver, B.C.—

Two pieces of fossiliferous rock from the Tertiary from Bow river, Blackfoot Indian reserve, Alberta. Access. No. 247.

Morgan, L., Grenville, Quebec.—

Four pieces of Chazy fossiliferous rock from Grenville, Que. Access. No. 195.

Orrell, H. S., Box 102, Collingwood East, Vancouver, B.C.—

A small box of fossils from Puget Sound group, Vancouver. Access. No. 199.

Perraud, A.—

A piece of fossiliferous rock from West Butte coal mines, Montana, McDermott and Son. Access. No. 194.

Reagan, Albert B., Nett Lake, Minn.—

Three pieces of fossiliferous rock from St. Anthony falls near St. Paul, Minn. Access. No. 189.

Robertson, Wm. Fleet, mineralogist, Department of Mines, B.C.—

A small box of fossils from Big creek in Lillooet district, B.C., beds extending from Spruce lake through to Big creek. Access. No. 205.

Snazelle, C. A., 26 Metcalfe st., Toronto, Ont.—

Fossils from British Tertiary and Pleistocene beds. Access. No. 188

Stirling, John T., Edmonton, Alberta.—

A piece of fossiliferous rock from the Paskapoo series from several miles west of Wetaskiwin, Alberta. Access. No. 191.

Watkins, Louis.—

Small collection from above the head of Long lake in Cascade Creek valley. Access. No. 232.

Acquired by Exchange.

Gregor, D. K., Columbia, Miss.—

A collection of Devonian material from Missouri. Access. No. 225.

Hibbard, R. R., Buffalo, N.Y.—

A collection of fossils, Hamilton formation and Moscow shales, section 5, 18 Mile creek, Erie county, N.Y., 14 miles from Buffalo. Access. No. 188.

Loomis, Prof., Amherst College, Amherst, Mass.—

A collection of Tertiary fossils from the Patagonian beds from Patagonia, S.A. Access. No. 167.

PALÆOBOTANY.

(W. J. Wilson.)

During the present year the work in palæbotany has been confined chiefly to an examination of a part of the large mass of unnamed material that has been accumulating for years, especially the collections from the Carboniferous rocks of southern New Brunswick and to the study, naming, and arranging of collections brought in by the field officers the past summer.

A collection made by Miss M. C. Stopes in 1911 in connexion with the preparation of Memoir 41 on the fossil plants of the "Fern Ledges" St. John, N.B., was sent in. These fossils were collected from Duck cove, Lepreau, and east of St. John harbour in the Little River group, and from the Joggins, N.S. As identified by Miss Stopes those from the Little River group are:—

Calamites Sp.
Asterophyllites acicularis Dawson. (=*A. equisetiformis* Schl.?)
Psilophyton sp.
Sphenopteris valida Dawson. (=*S. artemisiaefolioides Crepin.*)
Alethopteris lonchitica (Schlotheim.)
Alethopteris sp.
Neuropteris heterophylla Brongn.
Neuropteris eriana Dawson.
Rhacopteris busseana Stur.
Sporangites acuminata Dawson.
Cardiocarpon cornutum Dawson.
Cardiocarpon crampii Hartt.
Cardiocarpon sp.
Cordaites robii Dawson. (=*C. borassifolius* Sternberg.)
Cordaites principalis Germar.
Cordaites sp.
Those from the Joggins, N.S., are
Alethopteris lonchitica Schlotheim.
Lepidostrobus sp.
Cardiocarpon sp.
Cordaites sp.

A collection of considerable interest was made during the present summer by J. E. Hyde, from Parrsboro inlet, N.S. These specimens were examined and in part named and then sent to Dr. David White, of Washington, D.C., who kindly corrected and extended my list as follows:—

Calamites suckowi Brongn.
Calamites ramifer Stur.
Calamites cf. *C. cruciatus* Sternberg.
Lepidodendron cf. *L. alabamanse* D. White.
Lepidophloios cf. *L. laricinus* Sternberg.
Lepidophyllum sp.
Mariopteris eremopteroides D. White.
Renaultia microcarpa Lesq.
Neuropteris smithii Lesq. cf. var. *antiqua* D. White.
Cordaites robii Dawson.
Cordaites borassifolius Sternberg.
Whittleseya desiderata D. White.
Trigonocarpon, sp. nov.

Dr. White sends the following interesting notes on the above plants:—

"The comments informally noted in the following paragraphs are not intended to constitute a report; they merely embrace my notes and interpretations both as to identity of the species and as to correlations of the plant-bearing beds."

"The fragments of Calamites bearing the number 76 are probably all referable to the somewhat comprehensive type passing as *Calamites suckowi*, Brongn."

"The two fragments marked 77 represent a type with extremely narrow fine nodes and small leaf scars. A large number of the ribs are continuous across the nodes. Specimens such as this have sometimes been identified as *Asterocalamites radiatus*. They presumably are descendants of that species. *Calamites ramifer* Stur, is closely related; possibly identical. It is perhaps the oldest of the Pennsylvanian Calamarian types."

"The specimen which I tag 76a. approaches more nearly the Calamites cruciatus group. It is liable to be varietally distinct from any species heretofore described."

"The large number of leafy twigs of the Lepidodendron and the fragments of bark with narrowly diamond-shaped bolsters bearing leaves at the upper apices appear to belong to a single species which is very close to a species from the Lower Pottsville throughout the Appalachian trough, to which I have given the name *Lepidodendron alabamanse*. However, in your specimens the leaves are a little more slender and less distinctly sickle-shaped. Some of these rock fragments have detached cuticular remains of great perfection in detail and great interest. The Lepidodendra belong to an early Pennsylvanian group and deserve comparison with the fine specimens figured by Zeiller as *Lepidodendron Veltheimi*."

"The small fragments of No. 78 might belong to *Cordaites robii*, Dawson."

"Number 77b contains a fragment of a rachis marked with transverse gashes which probably correspond to the horizontal sclerotic discs in the petioles of Heterangium. Such stems bore fronds of Eremopteris and Aneimites. They are undoubtedly cycadofilic."

"Several fragments bearing the accession No. 78 are an early form of Neuropteris of the Schlehani group. The same group in this country was called *Neuropteris Smithii* by Lesquereux. This is not the typical *Neuropteris Smithii*, but approaches nearly to my variety, *Antiqua*. It is distinguished by the broad attachments of the pinnules and the close position of the nerves. This form in the Appalachian trough is characteristic of the upper middle region of the Lower Pottsville."

"The identical form represented by these fragments is present in the Appalachian trough. This has, I believe, the smallest pinnules of any variety of Neuropteris that has yet been found. The type of *Neuropteris Smithii* as originally described, from Alabama, is not much larger, but the pinnules are rounded and narrowly attached at the base, the narrow nerves being more strongly arched, more lax, and a little more distinct.

My experience in dealing with these small-pinnuled species of Neuropteris inclines me to the belief that all of these fragments which you sent represent a single very early type belonging to the *Neuropteris Schlehani* group, that is, the *Neuropteris Smithii* group."

"No. 78, tagged *Cordaites borassifolius,* Sternberg, is rightly named, I believe. Underneath the leaf fragments are a number of cycadofilic inflorescences which at first glance suggest Dawson's *Sporangites acuminata.* Probably they belong to Calymmotheca, and as such I would provisionally refer them to *Adiantites,* to which I doubt not they belong. I have exactly the same thing occurring with Adiantites in the Lower Pottsville."

"The specimens of Lepidophyllum represent a species quite distinct from, though ancestral to *Lepidophyllum lanceolatum,* Brongn. It differs from *L. Lanceolatum* by its smaller size, very much thinner and more delicate texture by the habitual indistinctness of the mid-rib ridges, and more particularly by the comparatively short and narrow sporangiophore. I have named this new species from Alabama, *Lepidophyllum.* . . . It is an interesting little scale, widely distributed, and in this country confined, so far as I remember, to the Lower Pottsville. The bract tapers a little more rapidly in the upper part than does the bract of *Lepidophyllum lanceolatum."*

"One fragment is a Mariopteris, and although the fragment is very small, I am practically certain that it belongs to my *Mariopteris eremopteroides.* Two other fragments are clearly a Renaultia, and although the margins are not very distinct, I think they are certainly *Renaultia microcarpa.* Lesq."

"The three fragments of Lepiodophloios bearing the number 77 I hesitate to identify specifically, but suppose it would do no great violence to the facts if they were tagged as *Lepidophloios* cf. *L. laricinus.* Sternberg."

"The specimens in No. 78 which you refer to *Whittleseya desiderata* D. White are clearly Whittleseya and I do not question the specific identification. It is an extremely interesting leaf, and I am very greatly interested in the examination of this suite of good specimens. In our flora of this age we have great numbers of *Whittleseya Campbelli* D. White instead of *Whittleseya desiderata,* which seems not rare with you."

"As already intimated, the fossils you send are undoubtedly Pottsville. They probably belong to the Upper-middle, or the upper part of the Lower Pottsville. The number of species is not large, especially among the fern-like types. Certainly the plants can *hardly be Upper* Pottsville."

"I have no list of the species from Harrington River at hand, and cannot, accordingly, make comparisons. It is probable, however, that the Harrington River Whittleseya is older than I supposed. The genus goes into the Lower Pottsville as *Whittleseya Campbelli,* while *Whittleseya integrifolia* Lesq. is known in the upper part of the Lower Pottsville in Tennessee."

"I think I understand the stratigraphic difficulties or better, the utter incompatibility of this correlation, as it will appear, but I cannot help it. Small as the collection in hand is, I am certain that it is older than the fern ledges flora with Megalopteris, *pecopteris serrulata,* Hartt and *Sphenopteris pilosa* Dawson."

"As already intimated, I have only the most hazy recollection of palæontological material from Harrington river, but if that material is as young as I have supposed it to be, it could hardly lie contorted and at an angle beneath the beds containing the flora you sent, except as the result of overthrust."

Harlan I. Smith brought in a small collection of fossil plants from Merigomish harbour, Nova Scotia. Among these there is one good specimen of *Calamites suckowi* Brongn, from Finlayson island in the harbour, and from the beach east of French point there are several specimens of a small *Calamite,* which probably are branches of the same species, though they are too fragmentary for definite identification. The genus Rhacopteris is represented by one or two specimens, and there are some poorly preserved pieces of what may have been trunks of trees. The specimen donated by Miss Simpson, through Mr. Smith, is probably from the adjacent Picton Mines, and is a typical *Neuropteris rarinervis* Bunbury.

A. O. Hayes collected about a hundred specimens of fossil plants from Kennebecasis island, St. John county, New Brunswick. These specimens chiefly represent Dawson's *Lepidodendron corrugatum* in different stages of decortication. It is not difficult to pick out a series of specimens connecting by gradual steps the extreme forms, so that it is quite probable that only the one species is present. Fern stipes are abundant at this locality, but the foliage is mostly absent. In Dr. Hayes' collection there is one stipe, which is 14 cm. long, which was at least bipinnate, three or four branches springing at a wide angle from each side of the rachis. The rock is so altered that no trace of the pinnules or veins remains, but a medial groove runs along the stem. About a mile west of Hispek, Dr. Hayes found rather poorly preserved plant remains in reddish purple shale. They are cordaite leaves, and seem to represent *Cordaites robii* Dawson, and perhaps *C. principalis* Germar.

D. D. Cairnes obtained a small collection of fossil plants from the Kenai formation, Yukon Territory, but it has not yet been examined.

George F. Sternberg collected a very interesting section of a coniferous tree trunk 7 feet long from the Cretaceous of the Red Deer river, Alberta. This specimen has been neatly mounted by Mr. Sternberg, and is now on exhibition in the Palæontological Hall.

Charles H. Sternberg brought in a number of good specimens of dicotyledonous and coniferous leaves from the Belly River formation, Red Deer river, Alberta. Conspicuous among these are *Castalia stantoni* Knowlton and *Cunninghamites pulchellus* Knowlton. This collection has not yet been carefully examined.

The thanks of the department are due to Dr. David White of Washington for kindly examining the fossil plants from Parrsboro.

Additions to the Palæobotanical Collections During 1914.

By Presentation.

Evans, W. B., Rothwell, P. O., Queens county, N.B.—One specimen of *Calamites* probably *undulatus* Sternberg, from the Rothwell Coal Company's mine. Rothwell P.O., Queens county, New Brunswick. Acc. No. 89.

Simpson, Miss, of Merigomish, Pictou county, N.S., per Harlan I. Smith.—One fossil plant (*Neuropteris rarinervis* Bunbury). Exact locality not given. Acc. No. 87.

Collected by Officers of the Geological Survey.

Dowling, D. B.—One specimen of sandstone containing plant impressions from the bank of the Saskatchewan river 1,500 feet east of Mire Creek mouth. Acc. No. 71.

Stopes, Marie C.—Sixty-three specimens of fossil plants from Duck Cove and "Fern Ledges," St. John, N.B. Acc. No. 72.
Seven specimens of fossil plants from east of St. John harbour, N.B. Acc. No. 73.
Two specimens of fossil plants from Lepreau, N.B. Acc. No. 74.
Seven specimens of fossil plants from Joggins, N.S. Acc. No. 75.

Hyde, J. E.—About 40 specimens of fossil plants from the Parrsboro formation, Pottsville, from bed B14, section on west side Parrsboro inlet, Parrsboro, N.S. Acc. No. 76.

About 55 specimens of fossil plants from bed No. 2, Parrsboro formation, section on west side of Parrsboro inlet, Parrsboro, N.S. Acc. No. 77.

About 60 specimens of fossil plants from the Parrsboro formation, section on west side of Parrsboro inlet. B. 16. Acc. No. 78.

Hayes, A. O.—About 100 specimens of fossil plants from the northwest shore of Kennebecasis island, St. John county, N.B. Acc. Nos. 79, 80, 81, 82, 83, 84, 88.

Twelve specimens of purple shale from 6,000 feet west of the bridge at Mispek, St. John county, N.B., along the wagon road and 1,000 feet northwest of road. These specimens show poorly preserved impressions of Cordaites. Acc. No. 90.

Twenty-three specimens of fossil plants from the east side of Courtenay bay and south of the mouth of Little river, St. John county, N.B. Mostly Cordaite leaves. Acc. Nos. 91, 92, 93, 94.

One specimen of *Calamites suckowi*, from Emerson creek, west of McCoy head, St. John county, N.B. Acc. No. 95.

Smith, Harlan I.—One fossil plant (*Calamites suckowi* Brongn) from Finlayson island, Merigomish harbour, Pictou county, N.S. Acc. No. 85.

Several specimens of fossil plants from beach on Merigomish harbour about one-half mile east of French point, Pictou county, N.S. Acc. No. 86.

Cairnes, D. D.—Thirty-eight specimens of fossil plants from Sheep creek, about 2 miles from mouth, Kluane mining district, Yukon Teritory. Acc. No. 96.

Six specimens of fossil plants from the left bank of Granite creek near its head. Kluane mining district, Yukon Territory. Acc. No. 97.

Sternberg, Geo. F.—A section of a silicified tree trunk over 7 feet long, and a detached piece of the same tree 3 inches long. From the west side of the road one-half mile northwest of Happy Jack ferry, Red Deer river, Alberta. Acc. No. 98.

Sternberg, George F.—Two specimens of fossil conifers from the Belly River formation, 2½ miles above Happy Jack ferry, south side Red Deer river, Alberta. Acc. No. 101.

Sternberg, Chas. H.—Twenty specimens of fossil plants from the Belly River formation about 8 miles below Happy Jack ferry, 100 feet above river level on the north side of the Red Deer river, Alberta. Acc. No. 99.

About 17 specimens of fossil plants including two of fossil wood from the Belly River formation, 3 miles below Happy Jack ferry, Head of Dead Lodge canyon, south side Red Deer river, Alberta. Acc. No. 100.

Two specimens of fossil leaves from the Belly River formation, 2½ miles above Happy Jack ferry, south side Red Deer river, Alberta (30 miles northeast of Brooks). Acc. No. 102.

Six specimens of fossil wood from Klintonel P.O., Bone coulée, Cypress hills, Saskatchewan. Acc. No. 103.

Mackenzie, J. D.—Ten specimens of fossil plants, Kootenay formation, from Flathead, B.C. Acc. No. 104.

MINERALOGY.

(Robt. A. A. Johnston.)

The volume of work in this Division is increasing greatly from year to year. During the interval since writing the last Summary Report (1913) over five hundred specimens have been examined and reported upon either by memorandum or in the course of personal interview. A very considerable amount of time is taken up in replying to inquiries of a specific character. The number of inquiries of this kind was very large during the latter half of the year.

The "List of Canadian Minerals" has been completed and when published will no doubt in some measure satisfy a want frequently expressed in different quarters, for a comprehensive list of mineral localities in Canada.

During the year great interest was manifested in the subject of radium ores and so persistent were the inquiries regarding the general characters of radium bearing minerals that it was thought advisable to make up a few special collections of such minerals and have them placed on loan at selected centres. The specimens employed in this way had of necessity to be secured from foreign countries. These collections were constituted as follows:—

Thorite.	Langesund Fiord.	Norway.
Samarskite.		
Monazite sand.	Bahia.	Brazil.
Autunite.	Lawrence county.	South Dakota.
Uraninite (Cleveite).	Satersdalen.	Norway.
Pitchblende.	Bohemia.	
Thorianite.	Ceylon.	
Carnotite.	Clarey Station.	South Australia.
Carnotite.	Montrose county.	Colorado.

The collections were placed in the care of the following organizations:—

Provincial Museum,	Halifax, N.S.
Nova Scotia Mining Society,	Sydney, N.S.
Canadian Mining Institute,	Montreal, Que.
Winnipeg Industrial Bureau Exhibit,	Winnipeg, Man.
Nelson Board of Trade,	Nelson, B.C.
Vancouver Chamber of Mines,	Vancouver, B.C.
Canadian Mining Institute, Cobalt Branch,	Cobalt, Ont.
Hon. Geo. Black, Commissioner,	Dawson, Y.T.
Prince Albert Board of Trade,	Prince Albert, Sask.
F. R. Fisher, Esq., Secretary, Edmonton Board of Trade,	Edmonton, Alberta.

Meetings of the Museum Committee have been held at such times as circumstances required, particular attention having been given during the year to museum floor mountings and to the extension of the museum's activities to educational and other institutions throughout the country. It is felt by all those in charge of museum work that great benefit cannot help but accrue to the progress of scientific work in Canada through arousing the interest of the rising generation. Apart from the schools that are scattered over the Dominion there are several organizations such as the Boy Scout and Girl Guide movements, Farmers' Institutes, and the like between which and the museum there might be a reciprocal interchange of favours which would be of mutual advantage.

Work Performed by Members of the Division.

Mr. Poitevin devoted himself assiduously to the duties of his office throughout the year. Until July 9 he was engaged in mineralogical work generally and in the care of museum materials. On the date indicated he proceeded to the Black Lake mines in Megantic county in the province of Quebec, where he remained until early in September. During this time Mr. Poitevin collected a large suite of specimens from this interesting locality. These specimens are now being investigated and will be reported upon in due time. From October 10 to December 15 Mr. Poitevin was engaged at the Harvard University museum, Cambridge, Massachusetts, U.S.A., in crystallographic and comparative studies on some of the materials collected during the summer season.

As in former years Mr. McKinnon's time has been devoted to the collection and preparation of materials for the Educational Collections of Minerals, the popularity of which in the schools of the country shows no sign of decreasing.

Collections of minerals have been distributed as follows:—

—	Grade 1.	Grade 2.	Miscellaneous.
Alberta	6	10	1
British Columbia	1	1	..
Manitoba	2	6	3
New Brunswick	3	4	1
Nova Scotia	1	7	..
Ontario	15	11	13
Quebec	28	8	..
Saskatchewan	1	3	..
Foreign	.	..	2
Total, 127	57	50	20

For the purposes of the Educational Collection, about twenty tons of material have been assembled during the past season principally by Mr. McKinnon. For assistance both in the way of liberal donations and in kindly advice in the securing of these materials, the Department is indebted to several gentlemen, more particularly the following:—

Mr. W. L. Parker, Buckingham, Que.; Dr. J. A. Bancroft, Montreal, Que.; Steph. Wellington, Madoc, Ont.; Mr. Paul Desjardins, Allumette island, Que.; Mr. A. A. Cole, Cobalt, Ont.; Mr. R. H. James, Cobalt, Ont.; Mr. G. E. Kaeding, Mr. Geo. B. Church, Mr. T. C. Lyons, South Porcupine, Ont.; Mr. P. A. Robbins, Mr. H. M. Stevens, Timmins, Ont.; Mr. A. R. Whitman, Schumacher, Ont.

Additions to the Mineral Collections During 1914.

Meteorites.

The museum collections have this year been enriched by large and important accessions to the collection of meteorites. Early in the year the Foote collection was secured by purchase from the Foote Mineral Company of Philadelphia. This collection embraces a large number of slices and individuals together with forty casts. The meteorites proper represent two hundred and five "falls" in addition to which twenty-one other "falls" are represented amongst the casts. It includes a very considerable number of rare meteorites such as Sacramento mountains, Kingston, Maubhoom, Charlotte, Emmitsburg, Murfreesboro, Senegal, etc., together with several that are of historic interest, amongst which may be mentioned Ensisheim, L'Aigle, and Mazapil. Of the stone showers which occurred near Holbrook, Arizona, July 19, 1912, there are over two thousand complete individuals in this collection. Further additions to the collection include a large end piece of Mukerop with one polished and etched surface, a very fine etched section of Willamette, and a unique section of the recently discovered Mount Edith (South Australia) iron.

The collection of meteorites when placed in position in the exhibition hall will constitute a very attractive and interesting exhibit.

The following additions have been made to the Museum collection of minerals during the year:—

Donations.

The late Dr. A. E. Barlow, Montreal.—Specimen of syenite with implanted crystals of corundum.

Mr. G. H. Bell, Salmo, B.C., per O. E. LeRoy.—Molybdenite from Lost mountain, Nelson mining division.

B. C. Oil and Coal Development Company, Victoria, B.C.—Two specimens of petroleum from Sage creek, Flathead river, East Kootenay, B.C.

D. G. Burleigh, Port Alberni, B.C., per F. G. Wait.—Native arsenic from Port Alberni, B.C.

Mr. H. J. Fetter, Fort George, B.C., per Collingwood Schreiber, Esq., C.M.G.—Eight clay concretions from Nechako river, B.C.

Mr. Charles R. Fletcher, Los Angeles, Cal., per Dr. E. Haanel.—Tourmaline from Pala, California.

Mr. Forbes M. Kerby, Grand Forks, B.C.—Silver ore from Union Franklin camp, Grand Forks mining division, B.C.

Mr. R. Harvie, Ottawa, Ont.—Samarskite from Maisonneuve, Berthier county, Quebec, calcareous sinter with impressions of plant leaves from bank of Niagara river at the Whirlpool, Welland county, Ontario; octohedra of cobaltiferous pyrite from South Lorraine, Timiskaming district, Ontario.

Mr. Joseph Legree, Renfrew, Ontario.—Crystals of molybdenite from Griffith, Renfrew county, Ontario.

Mr. P. E. Piche, Montreal, Quebec.—Molybdenite in calcite from Mount St. Patrick, Renfrew county, Ontario.

Mr. Harry G. Stokes, North Adelaide, South Australia.—Fine specimens of autunite and torbenite from Mount Painter, South Australia.

Mr. J. B. Tyrrell, Toronto, Ont.—Yukonite from Tagish lake, Yukon.

Dr. T. L. Walker, Toronto, Ont.—Timiskamite from Moose Horn mine, Elk lake, Timiskaming district, Ontario.

Professor R. C. Wallace, Winnipeg, Manitoba.—Selenite from Elephant hill, sec. 4, tp. 33, range 8, W., Manitoba.

Mr. Wm. Watts, Calgary, Alberta, per D. B. Dowling.—Coal from Midway, B.C.

Mr. Bush Winning, Ottawa, Ont.—Titanite from Little Rapids mine, Buckingham, Ottawa county, Quebec.

Collected by Officers of the Department of Mines.

D. D. Cairnes.—Series of ores from Quadra island, coast district, B.C.; series of rocks from Upper White River district, Yukon; lignite from Granite creek and lignite from Sheep creek, Kluane mining division, Yukon; gold coated with tellurides from Nansen creek, Yukon.

W. H. Collins.—Crystallized native arsenic from Long Lake Gold mine, township 69, Sudbury district, Ontario.

D. B. Dowling.—Coal, tar, and sandstone from SE. ¼ sec. 27, tp. 2, range 26, W. 4th mer.

E. R. Faribault.—Infusorial earth from Kejinkujik river, one-half mile below Loon Lake falls, Queens county, N.S.

J. Keele.—Five specimens of tiles from the Kingston Tile Works, Kingston, Ont.

O. E. LeRoy.—Epidote and garnet from Queen Victoria mine, Nelson, B.C.; silicified wood from Red Deer, Alberta; columnar calcite from Hillsborough, N.B.

A. T. McKinnon.—Auriferous schist and auriferous quartz from the Hollinger mine; auriferous quartz from McIntyre Porcupine mines; auriferous quartz from the Dome mine, Porcupine mining division, Ontario; molybdenite from Huddersfield, Pontiac county, Quebec; graphic granite from Bouchette, Ottawa county, Quebec; chiastolite schist from Winslow, Frontenac county, Quebec; calcite from Orford, Sherbrooke county, Quebec.

E. Poitevin.—Crystals of pyrite from the Emerald mine, Buckingham, Ottawa county, Quebec.

S. J. Schofield.—Sphalerite from the Florence mine; ore from the Silver Hoard mine; magnetite altering to martite from St. Mary river—Ainsworth mining division, B.C.; garnet crystal embedded in sulphides from the Sullivan mine, Fort Steele mining division.

G. F. Sternberg.—Fifteen nodules of clay ironstone and a series of specimens of quartz from a point 3 miles south of Steveville, Alberta.

M. Y. Williams.—Celestite from the Flemming quarry, Glen William, Halton county, Ontario: celestite from the forks of the Credit river, Peel county, Ontario: chert and limonite pseudomorph after pyrite from Cabot Head, Grey county, Ontario.

M. E. Wilson.—Crystal of diallage embedded in apatite from Buckingham, Ottawa county, Quebec.

W. J. Wright.—Series of 29 specimens of rocks and ores from Clyburn valley, Victoria valley, N.S.

By Purchase and Exchange.

Erythrite from Nipissing hill, Cobalt, Timiskaming district, Ontario.

Two large specimens of amethyst from Port Arthur, Ontario.

Small specimen of platinum and gold from Tulameen river, British Columbia.

Gold nugget weighing 38.14 ounces from Boulder creek, Atlin mining division, British Columbia.

Agate hydrolite from Ecuador.

Section of agate showing the effect of artificial colorations.

WATER AND BORINGS DIVISION.

(*Elfric Drew Ingall.*)

The work of collecting and recording information regarding deep borings throughout Canada was continued along the usual lines. A résumé of the aims and methods of the Division is here set forth. Through the newspapers and other sources of information knowledge is obtained of borings reported to be in progress at different points and by correspondence relations are established with the actual drillers. When their co-operation is secured, bags and other supplies are sent to them so that samples may be returned illustrative of each few feet of the rocks pierced by the borings. As these samples are received they are opened up and a portion of each set out in a small tray, the balance is filed away and held in reserve. The trays are arranged in series for detailed examination and comparison with similar samples previously obtained from other wells in the vicinity.

The characteristics of and variations in the strata thus ascertained are interpreted in connexion with what is known of the succession of the strata through the surface geological investigation made by officials of the Survey and others. If circumstances permit of the routine being promptly and continuously carried out the information thus obtained becomes available for the guidance of the operators during the progress of the well. However, the detailed examination of these samples is in its nature tedious, involving washing, treatment with acid, and other tests and microscopic examination, so that at present the policy of the Division is to concentrate on certain of the borings of greater importance geologically and economically. With regard to other borings all drillers' logs and sets of samples obtainable are filed and already the records contain a considerable amount of data of this kind.

Since its inauguration it has also been the aim of the Division to accumulate all published records of borings and measurements of geological sections in different parts of Canada. By plotting these sections to scale, diagrammatic information becomes available for sending out to drillers for their guidance in regard to the formations they are penetrating. Wherever information could be found relating to water, gas, or oil, encountered in boring, it has been incorporated in the records.

S. E. Slipper, who had been working on the geological staff in Alberta and incidentally watching boring operations in the Calgary district, has contributed the preliminary report which is given below. His efforts for the present will be directed to keeping a close watch on the above-mentioned district and to the working up of the very large amount of samples accumulated from the numerous borings made there. J. A. Robert has been employed since September 9 in a complete rearrangement of the accumulated material collected during the past five years of the work of the Division as well as in general routine. In this work he has been assisted by H. N. McAdam since October 9. It is hoped that when this work is completed that the very numerous samples which have accumulated since the inauguration of the work can be finally worked out in detail and that data will result of importance to the geologists in working out the problems in their special districts as well as to any one boring deep wells in the future.

The results of the work of the Water and Borings Division apart from the accumulation of records and illustrative sets of samples from borings, are made available to the public through reports made to inquirers, verbally or by correspondence, and through data utilized in the published reports of other officers of the Department. As sufficient information accumulates, the publication of reports on different districts in Canada will be possible.

In the recently issued report of the Commission of Conservation the great need for collecting reports of borings is pointed out. The publication of this report will serve a very useful purpose in educating the public and will strengthen the work of the present Borings Division.

This work was begun by the Geological Survey in 1885. In 1891 a report (Vol. V, Part Q) was issued giving particulars of all borings which were available in Ontario prior to 1891. This report gave plans of the different gas and oil fields of the province together with cross sections of the strata as worked out from these data. Important sets of samples of drillings were then collected and are now filed in the present Borings Division. Supplementary information of this nature was published in the annual reports. In the year 1898 maps showing the limits and distribution of the various gas and oil fields of Ontario were published from data resulting from field studies. A similar report for the use of those interested in borings in the northwest provinces was published in 1913 and includes all available boring records for the above region up to the date of issue.

The increasing activities in boring in recent years and its expansion over the whole of Canada called for special provision for the carrying out of the work and in the inauguration of the Department of Mines, the Act (6-7 Edward VII, chapter 29) provides that it shall be a function of the Geological Survey Division: "To study and report upon the facts relating to water supply for irrigation and for domestic purposes, and to collect and preserve all available records of artesian or other wells." It thus falls to the lot of the Borings Division to study all sources of information relating to these matters so as to collect all data bearing on the problems involved and by consultation with other members of the Survey staff, having special local knowledge, to interpret the information thus collected in the interests of the operators.

Outside the efforts made by the Geological Survey a certain amount of attention has been paid to this subject by the officials of the provincial governments. The annual reports of the Nova Scotia Government give details of the operations of their own drills. These are mostly core drills and are used at different points in the province in the search for seams of coal and for iron and other mineral deposits. In the other eastern provinces no systematic work has been done either in boring or in collecting records. The Provincial Government of Ontario has never operated drills, but the officials of the Bureau of Mines have published from time to time very complete studies of the gas and oil fields of the province with logs of borings and all information necessary to an understanding of the mode of occurrences of these minerals. In the northwest the official reports issued under the territorial governments contained particulars of the operations of drilling rigs a few of which were owned by the government. Numerous auger drills were similarly owned and loaned to the various municipalities and to others using them for shallow wells in search of water. This policy was discontinued, however, shortly after the inauguration of provincial governments.

The attempt to acquire the valuable geological and economic data obtained as a result of the hundreds of borings made in Canada in any one year is found in practice to be beset by many serious difficulties. The particulars must be obtained at second hand through the mechanics operating the drills and it is difficult in most cases to enlist and maintain their sympathetic co-operation. Then, too, it is seldom that the operator will have such a knowledge of geology that he will see the importance of the details the geologists finds it necessary to observe if any useful results are to be gained. It is further found difficult to impress operators with the necessity for sending complete tests of samples taken at close enough intervals in the drilling.

An added difficulty arises from the finely pulverized character of the rock material sent in which results from operations of the churn drill, the apparatus most generally used, since in such samples there is little chance of getting fossils. Larger fragments are sometimes obtainable in this method of boring, but it has been found very difficult to impress upon the working driller the need for preserving and transmitting these. It is important, also, that drillers should send unwashed samples and that the logs of wells should be accompanied by corroborative sets of samples.

Boring Developments Throughout Canada.

From the Nova Scotia field nothing has been received from the Lake Ainslie district notwithstanding numerous reports of prospecting work going on. The report of the operations of the Provincial Government has not yet come to hand.

From New Brunswick, a large number of new drillings have been added to those received in 1913 from the Moncton gas and oil field. A number of representative sets of these samples were set out and studied by W. J. Wright, and the conclusions arrived at will be embodied in his report of field work in that district. All the sets of drillings have been sorted and filed away. In boring operations the chief activity seems to have been in connexion with cleaning out and deepening operations. The gas from the Moncton field is still utilized in the towns of Moncton and Hillsborough.

Deep boring in Quebec has been practically limited to the operations of two companies in the St. Barnabé district of St. Hyacinthe county. This is situated a short distance northwest from the town of St. Hyacinthe. In the year 1910 a deep boring was put down to a depth of 1,880 feet by local capitalists in the search for natural gas or oil and a flow of gas was struck at 1,860 feet which still persists. This find was reported upon by Mr. Theo. Denis in his report of 1910 to the Quebec Government. The present operations are undertaken with the purpose of further testing this field. Full sets of drilling samples illustrative of the beds pierced for every 10 feet of the borings are being received by the Division and all the information possible is being given the operators.

The position of the anticlinals and synclinals and other factors of this region can only be ascertained in a very general way from surface geological studies as the rock exposures are so few and scattered. For this reason boring for some time will be experimental in character.

Mr. Robert Harvie, of the departmental staff, made an examination of the country in the vicinity of the borings in conjunction with Mr. Theo. Denis, Superintendent of Mines of the Quebec Government, and, as a result, further light was thrown on the problems involved in the experiment. When the policy of putting down a number of comparatively short holes, as suggeseted to the operators, has been carried out, deeper, borings placed more definitely along the crests of the anticlinals thus located, will show more effectively whether larger pools of gas exist than those partially proved by the boring ventures so far completed.

The samples of drillings so far received, seem to show only two formations: the upper red shales (Medina) down to 1,000 or 1,200 feet underlain by a very uniform set of grey sandy shales of Lorraine age down to 3,000 feet.

For assistance and information given, thanks are due to Mr. Napoleon Turcot, Mr. T. D. Bouchard of the Canadian Natural Gas Company, to Mr. Arthur Ryan and Dr. Connolly of the Natural Gas Development Company of Ottawa, and to Mr. W. G. Perkins and Mr. Edmund Coté, drillers for these companies, who collected full sets of samples for the Department.

In Ontario deep borings are naturally most actively carried on in the southern portions where the surface deposits are underlain by the sedimentary series of Palæozoic formations. These divide naturally into two main areas: that west of the Archæan axis which crosses the St. Lawrence river between Brockville and Kingston, constituting the Thousand islands, and the other east of this divide.

In the eastern area of Palæozoic rocks, occupying the wedge between the Ottawa and the St. Lawrence rivers, sporadic boring has been done in the past and a number of deep wells have been put down. Some of these reached almost to the underlying Archæan and in one case penetrated it for a few feet.

In Ottawa city a number of these wells have been put down to obtain water and in several instances a little natural gas was encountered. In the case of the deep bores put down at different points in the territory east of Ottawa, the object was the search for the gas or oil; but while neither was obtained in commercial quantities both were found to be of widespread occurrence. Considering the extent of the territory, the comparatively few borings, and the conditions under which some of them were prosecuted, the question of the occurrence of pools of gas or oil in portions of the region where the general geological conditions are fairly favourable, would seem to be still an open one. During 1914 no further ventures were made in this field.

West of the Archæan divide, already mentioned, the sedimentary strata underlie the whole of the peninsula of Ontario bounded by Georgian bay, Lake Huron, and Lakes Erie and Ontario. A line drawn from the southeast angle of Georgian bay to the vicinity of Kingston constitutes the easterly limit of this area, the underlying rocks of the Archæan complex rising from beneath the sedimentary formations constituting all the country to the east and north.

The lower Palæozoic strata, the limestones of Black River and Trenton age, outcrop from beneath the covering strata over a broad belt of country between the above mentioned eastern boundary and the line extending southeasterly from Collingwood on Georgian bay to the shore of Ontario. Along this belt of country numerous borings have been made during 1914 in search for water and small quantities of natural gas have been reported from isolated points, as in past years. Considering the lack of impervious covering strata, it is not to be expected that any lasting sources of natural gas or oil will be encountered in this area.

Westward, where the Trenton group lies beneath the shaly series of Utica, Hudson river, and Medina age, in two deep borings for water in the vicinity of Toronto flows of gas were said to have been encountered which would seem to be equal in importance to the limited flows reported from borings in previous years from this district from horizons in the Hudson river and the lower part of the Trenton. A similar occurrence was reported from a depth of 1,600 feet at Milton in Halton county. No logs are at present available from any of these wells, but from the depths reported the showing of gas might come from the bottom of the Utica or upper part of the Trenton.

North of this a development of great interest is reported in the finding of gas in considerable quantity in a boring made in Puslinch township, Wellington county. Here the surface rocks are limestones of Guelph age and the gas is reported as coming from a depth of about 2,000 feet. At this depth the bore would probably be in the upper part of the Trenton. According to reports, the flow and pressure were such as would differentiate this find from the small pockets of no lasting value apt to be encountered in deep borings in any part of the Palæozoic series. Northwesterly along the outcrop of the same strata of Guelph age boring was done about thirteen years ago and encouraging flows of natural gas were obtained in Amabel township, Bruce county. The field was not of very long endurance, however. It is reported that further search for gas by boring is likely.

In the older and well recognized natural gas districts of Welland, Kent, and Essex counties, reports show that boring has been undertaken at a number of points in the search for further supplies of gas. No definite particulars as to results have been obtainable. Near Amherstburg and Ojibway in Essex county, adjacent to the Detroit river, borings were made to test the underlying salt beds.

The most interesting development in western Ontario is that of the deep boring in the Oil Springs district of Lambton county. This district was for years one of the older and well recognized oil producers. The oil was obtained from the Corniferous at the comparatively shallow depth of 400 to 500 feet. Recent deep borings resulted in heavy flows of gas at a depth of about 1,900 feet, which would bring the bottom of the boring into the lower part of the Onondaga. The initial discovery in the spring resulted in a great rush to the district and in the prosecution of numerous boring enterprises not only in the immediate vicinity of the original gusher but throughout the adjacent parts of Lambton county. Later a number of the holes having proved "dry" and the pressure and volume of gas having rapidly dropped away the excitement subsided.

Deep borings for water supply have been put down at a number of points, notably at St. Thomas and at Guelph. At Sault Ste. Marie, Ontario, a similar undertaking seems to have resulted in no great supply.

During 1914 very little information has been obtained from Manitoba and only a few samples were sent in from shallow wells bored for water. Tests were made at Manitou and at Gilbert Plains for oil and gas with some flow reported in both cases.

In Saskatchewan, information is on file from deep wells such as: Moosejaw, two wells over 3,100 feet; Maple Creek, 2,100 feet; near Edgeley, 2,425 feet; Canora, 900 feet. Samples were also received from Viscount, Waldeck, Lehman, Keithville, Wilkie, Vanda, Baldworth, Nokomis, and Sovereign. Prospecting for oil and gas was carried on at Lancer, Hanley, Estevan, the Dirt hills, and at Battleford, and near Dundurn, in a well bored for water, traces of oil were reported at 210 feet.

In Alberta owing to the greatly increased activity this year in the Calgary field drillings have been received from important centres all over this province. These have all been carefully sorted and filed, and sets from special localities have been set out and examined in order to supply information to the many inquiries from prospectors in new districts.

Besides the Calgary district reported on by S. E. Slipper, information is on file relating to boring operations at Lethbridge, Macleod, Waterton lake, 1,753 feet, Pincher

Creek, 300 feet, Sweet Grass, 1,250 feet, Taber, 2,350 feet, Bow Island, 1,870 feet, Brooks, 2,795 feet, Coutts, Mud lake, Black Springs Ridge, Keho lake, Blood Reserve, Landbreck, Calgary, 3,414 feet, Gleichen, 106 and 100 feet, Aldersyde, 1,390 and 1,500 feet, Wetaskiwin, Red Deer, Lacombe, Wainwright, Cochrane, Moose Mountain, Jumping Pound, Mitford, Medicine Hat, 893 and 600 feet, Cardston, Steveville, Redcliffe, Carlstadt, Edmonton, Nakamun, Viking, Vegreville, Morinville, Irma, Athabaska Landing, Fort McMurray, Pelican, Moose Portage.

Nearly all the wells reported were drilled for gas and oil, a very small percentage being for water and in search of coal seams.

In British Columbia the diamond drill is freely used, as in mineral districts elsewhere, in testing ore deposits; but as all such operations are of purely local importance and do not yield any data of general geological significance records of them are not present in the files of the Division.

Some excitement existed during this year with regard to the district around Revelstoke based on the belief that gas or oil might be obtained there by deep boring. From the geological data available it would not appear that the conditions are favourable to such assumptions.

Deep boring has been prosecuted in the estuary of the Fraser river at Pitt Meadows where the sedimentary deposits with a considerable thickness of arkose at the base lie on the granitic rocks of the Coast batholith. A few samples of drillings were received for determination. As the arkose represents the broken up material of the adjacent igneous series it is difficult to distinguish one from the other in the pulverized samples resulting from the operations of the churn drill.

Thanks are due to Mr. C. B. McRae for information sent.

On the Queen Charlotte islands drilling for coal has been active and boring in search of natural gas and oil also received considerable attention during the year. No detailed data as to these are available, however.

Mr. Slipper, who has been located in the Calgary district for the past year, entrusted with the work of watching boring operations on behalf of the Geological Survey, contributed the following particulars of his own work in that connexion.

Calgary Gas and Oil Field.

(S. E. Slipper.)

Since December 26, 1913, the writer has been engaged in collecting data from the various wells which were being sunk for the purpose of prospecting for oil in southern Alberta. The work is under the supervision of E. D. Ingall, geologist in charge of the Water and Borings Division of the Geological Survey. Samples were taken from the wells at intervals of 5 feet in some cases but generally at intervals of 10 feet. At other wells samples are collected only at points where there is a change in the character of the strata being drilled through. These samples are examined and described in the field and then forwarded to Ottawa for future reference. The scope of the work is limited only by the enthusiasm of the different drillers and the willingness of the drilling companies to co-operate with the division in its endeavours.

Systematic information is being obtained from the following wells, west of the 5th meridian:—

Calgary Petroleum Products Company, wells No. 18 and No. 2—section 6, township 20, range 2.

McDougall Segur Oil Company, section 16, township 21, range 3.

United Oil Company, well No. 1, section 3, township 20, range 3.

Alberta Okotoks (Alberta Petroleum Consolidated No. 1) section 1, township 20, range 3.

Herron Elder (Alberta Petroleum Consolidated No. 2) section 1, township 20, range 3.

Western Pacific, section 31, township 19, range 2.
Fidelity, section 9, township 20, range 2.
Record, section 4, township 19, range 2.
Southern Alberta, section 18, township 20, range 2.
Calgary, Alberta, section 34, township 17, range 3.
Dome, section 12, township 25, range 3.
Purity, section 34, township 25, range 5.
Livingstone Fork Syndicate, section 15, township 9, range 2.
British Alberta, section 11, township 23, range 5.
Monarch, section 5, township 32, range 6.
Ottawa Petroleum, section 7, township 32, range 5.
Mount Stephen, section 25, township 32, range 7.
Prudential, section 1, township 20, range 3.
Black Diamond No. 1 (down to 1,400 feet), section 34, township 19, range 3.
Sterling Oil Company, section 15, township 17, range 3, from the Sugar Oil Company well, section 1, township 1, range 12, west of the 4th meridian, and from the Acme well and wells No. 1 and No. 2, Alberta Associated Oils.

To all of these companies the writer is greatly indebted not only for the permission to obtain samples, logs, and other data, but for other courtesies as well. Special thanks are due to the Calgary Petroleum Products Company for the accommodation which they afforded the writer during the winter season of 1913-14. The writer is also indebted to the following gentlemen for advice, information, and many other courtesies: Mr. A. W. Dingman, managing director, Mr. C. Naramore, superintendent, and C. W. Dingman, all of the Canadian Petroleum Products Company; Mr. Wm. Pearce; Mr. Joseph Sinclair, consulting geologist, Alberta Associated Oil, etc.; Mr. Clyde Segur, superintendent, MacDougall Segur Company's well; Mr. Wm. Livingstone, and Mr. J. D. Pugh, of the Southern Alberta Oil Company; Mr. O. G. Devenish, managing director, United Oil Company; Mr. Geo. Buck, of the Black Diamond Oil Company; Mr. Joseph Brown, field superintendent, Fidelity Oil Company; Mr. J. Kelso; Mr. Johnston of the Purity Oil Company; Mr. Geo. Dickson, consulting geologist, Sterling Oil Company; Mr. Pearson of the Ottawa Petroleum Company; and Mr. Theodore Sayler.

To the drillers our sincere acknowledgments are due. Owing to the transient nature of their occupation it is impossible to mention all of those to whom we are indebted. However, we are particularly indebted to Messrs. M. Hovis, J. Hovis, J. Brown, J. O'Day, G. Reynolds, A. Van Alst, Weir, Elder, W. Cannon, T. G. Felker, Northwest Drilling Company, including drillers Butchers and Shappat, drillers of the International Supply Company, Janse Drilling Company, Calgary Diamond Drilling and Oil Company, and others.

The MacDougall Segur Oil Company was the first to begin drilling operations. They "spudded in" on section 16, township 21, range 3, west of the 5th meridian, in January, 1913. Soon afterward on January 25, well No. 1 of the Calgary Petroleum Products Company was started near a gas spring on section 6, township 20, range 2, west of the 5th meridian. On October 6, 1913, at a depth of 1,556 feet the Calgary Petroleum Products Company penetrated an oil bearing sandstone and a small quantity of a very light oil was obtained. This oil was cased off and drilling continued. Besides the oil several gas horizons were passed through. After this discovery other companies which had already been formed began drilling. The Black Diamond No. 1, southern Alberta, Federal, Western Pacific, and United No. 1, were all drilling in the spring of 1914. On May 14, the Calgary Petroleum Products Company's well No. 1 encountered a second oil bearing stratum at a depth of 2,718 feet. The second strike brought many other companies into the field and drilling became general over the greater part of the foothills region of southern Alberta. There were 44 drilling outfits which began to operate, but a number of these have ceased work.

Cable tools, with the California type of standard rig, are in general use in the field. Diamond drills and a rotary type using a "fish tail" bit or revolving steel disc cutters are also being operated. A pole-tool outfit was used by one of the companies for a time. Drilling is slow and difficult because most of the wells are boring through strata that are highly inclined and of varying hardness. Hence, crooked and badly caving holes are a continual source of trouble.

The Calgary Petroleum Products Company's well No. 1 produces a light greenish-yellow oil. The following is the report of an analysis, made by E. Stansfield of the Mines Branch, Department of Mines, on a sample of crude oil from Dingman well No. 1. This report was furnished through the courtesy of Mr. A. W. Dingman, managing director:

> The oil was of a yellow colour, showed flourescence, and was practically free from any sediment; it possessed a strong unpleasant odour.
>
> Specific gravity: By hydrometer at 60 degrees F. = 0.756.

Distillation Test.

Degrees.	Per cent by vol.	Specific gravity.	Colour of distillate.
76-100	14·4	0·702	Yellow.
100-120	28·3	0·729	Orange.
120-140	19·3	0·746	Orange.
140-160	11·3	0·760	Yellow.
160-180	7·0	0·774	Pale yellow
180-200	4·3		
200-220	3·4		
220-250	2·8	0·791	Almost colourless.
Residue	6·6	0·874	Dark brown.
Loss	2·6		
	100·0		

Distillation began at 76 degrees C.

Specific gravity of the oil calculated from the above test equals 0.752; sulphur 0.10.

This oil was obtained at a depth of 2,718 feet. The production has not been stated.

The Moose Mountain well in section 34, township 23, range 5, west of the 5th meridian, obtained a small quantity of a dark green oil, which on analysis gives:—

Gasoline	20 per cent.
Kerosene	50 "
Lubricating oil	24 "
Solids (not analysed)	6 "

Analysis by E. G. Voss, B.Sc.

This oil comes from a depth of 1,690 feet. Several other wells in the district report small seepages of oil.

TOPOGRAPHICAL DIVISION.

(W. H. Boyd.)

The organization of the Topographical Division at present is as follows: chief topographer, 3 topographers, 1 triangulator and computer, 6 junior topographers and an editor, the staff being augmented this year by the addition of 2 junior topographers and the editor, thus greatly increasing the efficiency of the Division.

The Division has lost for a while the services of A. C. T. Sheppard who has volunteered for overseas service with the Engineers going with the Second Contingent. Before taking up his duties with the Engineers, his work was arranged so that it can be carried on satisfactorily by other members of the Division.

Field Work.

Field work in connexion with mapping was carried on during the season in the following areas: Rainy Hollow map-area, British Columbia; Revelstoke sheet and Ainsworth map-area, British Columbia; Flathead and Crowsnest sheets, British Columbia and Alberta; Sheep River map-area, Alberta; Athabaska lake, Alberta and Saskatchewan; Thetford and Black Lake map-area, Quebec; New Glasgow map-area, Nova Scotia.

Traverse control for mapping purposes was carried on in Queens county, Nova Scotia, and triangulation for control of future topographical mapping was executed in the Similkameen and Osoyoos districts, British Columbia.

Bad weather and smoke greatly hampered some of the parties; nevertheless, a great amount of work was accomplished.

RAINY HOLLOW MAP-AREA, BRITISH COLUMBIA.

W. E. Lawson in Charge.

This map-area lies between the International Boundary and the British Columbia-Yukon boundary and includes a strip of country adjacent to the Dalton trail; it also includes the Rainy Hollow mining camp. The map will be published on the scale of $\frac{1}{250000}$ with a contour interval of 250 feet. Photo-topographical methods were used, supplemented by traverses of all trails. Mr. Lawson reports that the easiest route into the district is by way of Haines, Alaska; from this point there is a wagon road as far as Rainy Hollow camp.

R. G. Scott and D. H. Calhoun were attached to the party as assistants.

Mr. Lawson extends his thanks to members of the International Boundary Survey for information readily supplied.

REVELSTOKE SHEET AND AINSWORTH MAP-AREA, BRITISH COLUMBIA.

F. S. Falconer in Charge.

This sheet covers the tract of country between latitudes 51° and 51° 30′ and longitudes 118° and 119°. The town of Revelstoke lies in this sheet. The map will be published on the scale of $\frac{1}{250000}$ with a contour interval of 250 feet. Photo-topographical methods were used, supplemented by traversing.

Before commencing work on the Revelstoke sheet, Mr. Falconer was engaged in mapping a small area in the vicinity of Ainsworth, B.C. This map, which includes the working mines in that area, will be published on the scale of $\frac{1}{2100}$ with a contour interval of 50 feet. Photo-topographical methods and traversing were used for this map.

W. R. Fraser and H. H. Graham were attached to the party as assistants.

FLATHEAD AND CROWSNEST SHEETS, BRITISH COLUMBIA AND ALBERTA.

A. C. T. Sheppard in Charge.

These sheets cover the tract of country lying between latitudes 49° and 50°, and longitudes 114° and 115°. Field work on these sheets was started last year by Mr. Sheppard. This season he was able to complete the work. The maps will be published on the scale of $\frac{1}{250000}$ with a contour interval of 200 feet. Photo-topographical methods were used for the mountainous portions of the area and traverse methods for the low-lying parts.

C. H. Freeman was attached to the party as topographical assistant and K. D. McDonald, W. H. Miller, and E. J. Sproule as assistants.

SHEEP RIVER MAP-AREA, ALBERTA.

E. E. Freeland in Charge.

This map-area embraces the oil region south of Calgary and is included in tps. 19, 20, and part of 21, ranges 2 and 3, W. 5th mer. The map will be published on the scale of $\frac{1}{62500}$ with contour intervals of 20 feet. The traverse method of mapping was used. Primary levels were run over the area. It was not possible to complete the mapping of this area this season.

E. M. Abendana, S. E. Prowse, D. S. McPhail, M. Fredea, J. B. Bonham, R. S. Adams, and H. M. Peck were attached as assistants; of these Mr. Prowse, Mr. Fredea, and Mr. Bonham left about the end of August for Valcartier camp for home service with the Engineers.

ATHABASKA LAKE, ALBERTA AND SASKATCHEWAN.

A. G. Haultain in Charge.

This work consisted in a transit and micrometer survey of Athabaska lake for the purpose of forming a base control for future exploratory work in that region. Owing to the nature of the traverse and the great number of islands on the north shore, the progress of the work was necessarily slow; however, Mr. Haultain succeeded in traversing 400 miles of shore line. Another season's work will be required to complete the survey.

THETFORD AND BLACK LAKE MAP-AREA, QUEBEC.

D. A. Nichols in Charge.

The mapping of this area was started last year by Mr. Nichols; this season he succeeded in completing the work. This map, which includes the asbestos mines of Thetford and Black lake and the asbestos and chrome properties in the vicinity of Belmina, Breeches, and Little St. Francis lakes, will be published on the scale of $\frac{1}{62500}$ with contour interval of 20 feet. The traverse method of mapping was used. Primary levels were run over the area.

C. B. Bate, E. Leslie, J. A. Macdonald, M. H. S. Penhale, C. H. Palmer, J. A. Ciré, and L. S. Adlard were attached to the party as assistants. Of these Mr. Bate, Mr. Leslie, Mr. Penhale, and Mr. Palmer left the party early in August for war service.

NEW GLASGOW MAP-AREA, NOVA SCOTIA.

B. R. MacKay in Charge.

Mr. MacKay continued the work on this area and succeeded in completing it this season. The map, which includes the towns of New Glasgow, Stellarton, Westville, and Thorburn and the coal mines in that vicinity, will be published on the scale of $\frac{1}{24000}$ with a contour interval of 10 feet. The traverse method of mapping was used. Primary levels were run over the area.

M. J. McMillan, P. Earnshaw, A. C. Evans, J. W. Spence, C. A. MacKay, J. H. T. Morrison, C. W. Ryan, G. O. Van Amburg, and F. C. Wilson were attached to the party as assistants.

Mr. MacKay extends his thanks to the Acadia Coal Company, the Intercolonial Coal Company, the Nova Scotia Steel and Coal Company, the Maritime Bridge Works, the Superintendent of the Truro and Sydney division of the Intercolonial railway, and many others, for valuable assistance.

TRAVERSE CONTROL AND TRIANGULATION.

S. C. McLean in Charge.

Traverse Control Work in Queens County, Nova Scotia.—This traverse was started at the intersection of the Queens County line with the Caledonia-Annapolis road and follows the Queens County line southwesterly to the corner of Queens, Shelburne, Digby, and Yarmouth counties; from this point it runs southeasterly to Port Herbert. The line, 60 miles long, is well cut out; the elevations of stream crossings, lakes, etc., are plainly marked on the ground. Transit and stadia were used for this work. Levels were run from Lowes Landing, Lake Rossignol, to the intersection of the Queens County line with the Caledonia-Annapolis road, a distance of 20 miles.

Triangulation in the Similkameen and Osoyoos Districts, B.C.—This triangulation which was started last year by Mr. McLean, was continued this season and completed. The triangulation extends from the International Boundary, between longitudes 119° and 120°, to Nicola lake, across to the Okanagan valley and north to Shuswap lake, where it is connected to the triangulation of the Railway Belt by the Department of the Interior.

R. C. McDonald was attached to the party as technical assistant, and J. B. Wilkinson as assistant for the work in British Columbia.

Mr. McLean extends his thanks to Mr. Whitman, Deputy Commissioner of Crown Lands, Nova Scotia, Mr. Hiram Donkin, Deputy Commissioner of Public Works and Mines, Nova Scotia, and to Mr. L. R. Andrews, District Forester, Vernon, B.C., and his staff for valuable assistance.

SUDBURY RECONNAISSANCE.

The writer spent a portion of the summer in the Sudbury district, Ontario, making a reconnaissance of that area with a view to topographical work in the near future. Mr. Dickison of this office, acted as assistant on this work.

CANADIAN ARCTIC EXPEDITION.

K. G. Chipman and J. R. Cox of this division, who were appointed geographer and assistant geographer, respectively, to the southern party of the Canadian Arctic expedition, are still in the north. Mr. Chipman has sent out the following report of their work.

"As geographers with the southern party, Canadian Arctic expedition, J. R. Cox and I left Ottawa, June 1, 1913. We left Victoria, B.C., on the *Karluk*, and in Nome, Alaska, transferred to the gasoline schooners of the southern party. The heaviest ice conditions known in recent years forced the party into winter quarters at Collinson point, Alaska, on September 12, 1913.

"Since the coast in that vicinity had been recently well mapped by Mr. E. DeK. Leffingwell, we could not undertake any extensive work along the coast. We made, however, on the scale of $\frac{1}{24000}$ a map of the harbour at Collinson point and vicinity, extending it inland to include some 10 square miles of tundra with 20-foot contours. The harbour was thoroughly sounded.

"During the winter a series of solar, stellar and lunar observations were undertaken. These were for astronomical position, variation of compass and chronometer ratings, as well as to make us familiar with various methods and the technique of making these observations at low temperatures.

"Mr. W. L. MacKinley, the meteorologist of the southern party, was on the *Karluk* and in his absence the tide gauge was set up and kept in operation during a portion of the winter by Mr. Cox, and the other meteorological work, so far as we could carry it out, divided among Mr. O'Neill, Mr. Cox, and myself.

"In March, 1914, Mr. Cox and I left Collinson point for work to the east of the Canada-Alaska boundary. Five days were spent at the boundary securing a series of time observations to tie our position at Collinson point to the boundary and to check our watch ratings. In connexion with geological work done on the Firth, or Herschell Island river by Mr. O'Neill, Mr. Cox made a traverse of the river to the vicinity of its crossing the boundary. He has also mapped the Arctic coast of Canada from the boundary to the mouth of the Mackenzie river.

"Since the opening of navigation on the Mackenzie as much work as was possible under the conditions has been carried out in the Delta. The West branch has been mapped and large portions of the middle and east branches, with a number of cut-off channels and smaller channels used in winter sled, or summer whale boat, travel. The surveys have been carried through to Arctic Red river and to Fort MacPherson, and astronomical positions determined at these places as well as at several points through the Delta.

"Our map will thus include a considerable portion of the Delta and the coast line to the Canada-Alaska boundary. The carrying of our astronomical position from the boundary to Fort MacPherson and to Arctic Red river will furnish a tie for the work of previous explorers in this lower Mackenzie and Peel Rievr country.

"Throughout the year as much experience as possible has been gained in work, travel, clothing, food, etc., as adapted to conditions in the Arctic."

BIOLOGICAL DIVISION.

BOTANY.

(John Macoun.)

Since the date of my last Summary Report I have continued at work on the flora of Vancouver island confining my studies chiefly to the vicinity of Victoria and Sidney. As I reported last year my residence on Vancouver island has enabled me to collect and study cryptogams in a way they have never been studied in Canada before. Most cryptogams except fungi are in prime condition in the autumn and winter and the mild climate makes it possible to collect during the whole winter. The result has been that I have made very large collections of mosses, lichens, hepaticæ, sea-weeds, and woody fungi during the past year, nearly all of which have been sent to specialists in order that my determinations might be verified or corrected. In all groups referred to species new to science were collected many of which have been described in *The Bryologist* during the year. Dr. J. Dearness, London, Ont., has determined for me this autumn 196 species of fungi as a preliminary to a complete list of the fungi of Vancouver island. During the summer months much of my time was devoted to flowering plants, short trips being made from Sidney for that purpose. Three weeks were spent on Mayne island in May and June and early in July in company with Dr. M. O. Malte I went for a few days to Mount Benson.

All my collections of cryptogams have been kept at Sidney for reference, a set being mounted as the specimens are named. One set of the flowering plants is sent to the museum (more than 500 sheets during the past year) for the herbarium and a duplicate set kept for study and reference at Sidney. This duplicate set should some time be presented to the provincial herbarium at Victoria or to some other provincial institution as it will include practically all the plants known to occur on Vancouver island.

BOTANY.

(J. M. Macoun.)

Aside from what may be called the routine work of the botanical division there is little to report for the year 1914 so far as the office and herbarium are concerned, the work of the year having been confined almost entirely to the determination of collections and to the mounting of a very large number of specimens and their arrangement in the herbarium. Before the spring of 1912 the office work of the Division was divided between Professor Macoun and the writer. Since it was decided that Professor Macoun should devote his energies to the study of the flora (chiefly cryptogamic) of Vancouver island and reside there, the writer has had to devote more and more time to the determination of the specimens sent in by working botanists throughout the Dominion. The daily routine work also has greatly increased with the result that while three or four important publications are almost ready for the press they cannot be completed until the writer is free to devote himself exclusively, for a time at least, to such work. These manuscripts include a flora of the Hudson Bay region, a flora of Ottawa and vicinity, a flora of the Maritime Provinces, and shorter papers dealing chiefly with the geographical distribution of plants. The flora of Vancouver island is also far advanced, one more season in the field being all that will be necessary for its completion. None of these works can be completed, however, until some of the larger herbaria and botanical libraries have been visited in order that difficult species may be compared with the types and botanical literature consulted. The number of mounted sheets in the herbarium has almost doubled in the last five years and it is becoming more difficult every month to find a place in our present cases for mounted material.

The period between the date of my last Summary Report and my departure for the field in May was devoted chiefly to the routine work of the Division which increases from year to year, but time was found to bring almost to completion the flora of the Ottawa district, a work begun by Professor John Macoun and continued by the writer and Dr. M. O. Malte of the Central Experimental Farm. Two chapters have still to be written, one dealing with the physical and geological features of the region covered by the flora, the other having to do with the flora of the district from an ecological viewpoint. Before this work can leave our hands, however, further study must be given to a few genera, a few species have still to be described, and some matters of nomenclature settled. As time permitted, and chiefly at night, collections of previous years that had been untouched were worked over and specimens taken out for mounting and by the end of April this work was completed. For the first time in twenty-five years I went to the field leaving practically no unexamined material behind me. As is shown below more specimens were distributed to other herbaria during the first four months of the year than during the same period in any previous year. No plants have been mounted and none distributed since last April.

As another season's field work was necessary to complete the flora of Vancouver island, I was instructed to spend a few weeks on the islands in the Gulf of Georgia and to devote the remainder of the season to the north end of Vancouver island which has never been studied botanically. Pursuant to these instructions I left Ottawa for Vancouver island May 8, and after a few days spent with Professor Macoun at Sidney in going over his collections of the previous year we went in company to Mayne island where I remained until June 8, when instructions reached me to the effect that I was to go at once to Bering sea as the Canadian representative on a commission appointed to study and report upon the condition of the fur-seal rookeries of the Pribylov islands. While on Mayne island very complete botanical collections were made, the flowering plants by the writer, the cryptogams by Professor Macoun. My collections were all worked up in the field as I had the necessary books with me, and they include several additions to the known flora of the region and add not a little to our knowledge of the distribution of plants in that part of British Columbia. I had already spent part of four seasons on the Pribylov islands and in 1898 the United States Government had published the results of my botanical work there. Last season with this publication in my hands and abundant time at my disposal I was enabled to add five additional species to the known flora of these islands and to make also very large and complete collections, the best collection of flowering plants I ever brought from the field. All the necessary books being in the island library I was able there also to work my whole collection up in the field so that all that remains to be done with my 1914 collections is to select the specimens for mounting and write the labels for them.

Since my return from the field my time has been devoted almost exclusively to routine work interrupted by the writing of several reports and memoranda relating to the fur-seals. In my office work I have been greatly hampered by the continued absence through sickness of Miss Stewart, by whom much of the routine of the division has beeen carried on for many years. Her absence has made it necessary for me to do everything myself, except the typing of correspondence and reports, the result being that no progress has been made with permanent work and several collections made last season have not yet been touched. Chief among these is a collection made by F. Harper on the Athabaska and Mackenzie rivers and between Lake Athabaska and Great Slave lake. This collection includes apparently most of the species known to occur in the region traversed, but the specimens are so poor and the material so scanty that much time and study must be devoted to it before a complete list can be prepared. The collection received from Mr. Johansen is also a disappointment. In a letter dated August 21, 1914, sent from Baillie island. Mr. Johansen says:—

"During our stay at Collinson point, 1913-14, I have collected a rich material of plants (both Cryptogama and Phanerogama) around here, both in the fall of 1913 and the summer 1914. I also collected plants up Sadlerochit river east of Collinson point (November, 1913), and especially west of Kongergevik (June-July, 1914), as also where landing at Martin point and Tay reef July-August, 1914, and at Spy island September, 1913; and finally a rich collection of plants from Herschell island, August, 1914. Altogether I have a very rich material concerning land and fresh-water plants, comprising all the different ones I saw and mostly many of each species. Together with my many and continuous notes about the appearance and biology of the plants and the photographs I have taken of these, I hope it will be possible afterwards to write an almost complete botanical description of the coast, where we have spent the past year. The collected specimens (outside of the pressed plants) have been landed at Herschell island to be sent to Ottawa Museum."

Mr. Johansen refers to having collected all the land plants he saw, but the specimens which have reached the Department include cryptogams only. These, as is the case with cryptogams collected by ourselves, will have to be worked up by specialists in the United States as we have no cryptogamic botanists in Canada.

D. D. Cairnes brought with him from the Yukon district a small collection of the grasses of the region. These have beeen determined and the list included in Mr. Cairnes' Summary Report.

Just before the close of the year a collection of about 150 species was received from Mr. W. C. Sandercock, who was attached to Mr. Drysdale's party working in the Ymir district, B.C. There has not been time to determine or study these plants, but the specimens are good and they appear to include several species not before known from the district.

During the year 2,307 sheets of botanical specimens were mounted and placed in the herbarium, and 1,835 sheets distributed to other herbaria. No record was kept of the number of letters received, but 824 were written.

Miss Stewart's work up to the time of an accident was in every way satisfactory, and each year adds to her value. The Ottawa collection of flowering plants is now in her charge. Such clerical assistance as I have had during the past two months has been given me by Miss McCann, who has performed her duties in an efficient manner.

ZOOLOGY.

(P. A. Taverner.)

The year 1914 has been marked by a decided and healthy growth in all branches of the zoological division. The work is well organized, good series of specimens came in to our collection and the preparatory staff has been well employed.

Our permanent staff was augmented during the year by the addition of Claude Johnston, who assumed the duties of colourist in the preparation department on the first of May, and has since fulfilled them in a most efficient and satisfactory manner.

We have also had the temporary assistance of two helpers in the same department who have been engaged in cleaning and remaking old bird-skins and in preparing large mammal-skins for tanning and storage. For tanning it is intended to provide a suitable plant which will enable us to prepare our large skins in a more satisfactory manner, and at considerably less expense, than through commercial jobbers. With this installed one of our greatest anxieties—the safety of our large specimens—will be removed.

In the field, we have had the assistance of Francis Harper collecting and taking notes with Mr. Camsell's Athabaska-Great Slave expedition and Frank Hennessey, who was with the writer most of the season on Chaleur bay, and who prepared his work with his usual efficiency.

Six new cases for the storage of birds and small mammals have been procured and have relieved the congestion in those collections considerably. A new case for the permanent storage of this material has been adapted from drawings kindly furnished by Dr. Clyde Todd, of the Carnegie Museum, Pittsburg. An experimental case from these designs is under way and it is hoped will prove successful.

Cases and boxes for the safekeeping of our large and valuable entomological collections are ordered and arrangements have been made with the Entomological Branch of the Department of Agriculture to have the purely scientific collections of that department stored with and included in our collection, thereby very much enhancing the working value of both and leaving the Entomological Branch more free to direct attention towards economic problems of entomology.

We have now three cases adapted to zoological exhibition in the museum. One of these is a large 14×14 case obtained this year and now filled with temporary groups which serve to indicate the style of work contemplated in the future.

The Division has had two parties in the field during the past summer. One, composed of the writer and C. H. Young, worked shores of Chaleur bay, on Miscou island, New Brunswick, and at Percé and Gaspe, Quebec. A preliminary report of work follows this report and a detailed one is in course of preparation.

The other expedition made by this Division was undertaken by Francis Harper who accompanied the Camsell expedition to Great Slave lake from Lake Athabaska over ground never before travelled by a scientific observer. Though the exigencies of travelling did not allow of extensive collections the results were very satisfactory. A preliminary report of the trip follows my own and a detailed one is under preparation.

R. M. Anderson, mammalogist with the Canadian Arctic expedition spent the summer on the Alaska Arctic coast with headquarters at Collinson point. The arrival of the specimens he reported as having been sent out last year, was delayed by the wreck en route of the ship carrying them and only reached us this year, together with the material gathered since their despatch. They include 77 mammals and 208 birds.

Advantage was taken of the presence of C. H. Young, of this Division, in England, during the latter part of last year to secure skins of some of the commoner Old Country birds. He collected some 32 specimens. These represent most of the commoner species obtainable at that season of the year, and will be available to form the nucleus of an exhibition of mounted birds illustrating the birds of England, should it be deemed advisable at a future date to make such an exhibit.

The general office work of the Division has proceeded satisfactorily. The birds of the collections have been studied and determined in their systematic order as far as the night-hawks. Many old skins have been relaxed, cleaned, and remade and so saved from destruction by grease and other destructive agencies and all have been taken care of in our new temporary cabinets, so as to be fairly accessible.

Through the summer, Miss Bentley did good bibliographical work and embodied a considerable amount of old and recent literature in our index files for aids to the study of ornithological conditions in the Dominion. It is due largely to her energy and interest that these indices are rapidly becoming most valuable aids to our work.

The preparatory department of the Division has been ably directed by our chief preparator, Clyde Patch. A considerable number of our old specimens have been made into temporary groups showing Dall's Sheep, Rocky Mountain Goats, Fur Seals, and Atlantic Coast birds in their natural surroundings. These have been put in a large four way group case and make effective exhibits. Through the summer, the department collected material for a number of small bird and other species groups for the systematic collections; these have been temporarily placed in cases borrowed from other divisions of the museum until permanent ones more appropriate to their use are secured. Our most ambitious undertaking of this nature now under way, is a lobster group, showing a submarine scene with lobsters, the traps in which they are caught, and the natural accessories of their habitat.

Since our return from the field Mr. C. H. Young has been going over our oological collections, verifying data and determining and arranging the collections in the new standard storage cases provided for such specimens.

Owing to the press of routine work we have not been able to accomplish a great deal of original research work; our time being largely taken up with the arrangement and determination of old material, and the collection of data in preparation for future original work. From the Levis collection, from Teslin lake, Yukon Territory, obtained last year, a new sub-species was separated and described in the "Auk" for July, 1913, under the title of *Dendragopus obscurus flemingi.* This description appeared later in our own publication series as Bulletin No. 7. A popular outline account of the salient results of the previous season's field work at Point Pelee, Ont., was also prepared and published in the November number of the "Ottawa Naturalist."

Reports on the ornithology of Chaleur bay and upon the relation of the cormorant to the salmon fisheries are in preparation and will be published at an early date.

Our collections have been made use of by a number of students and investigators outside our own staff.

The United States Biological Survey have borrowed specimens and examinations of specimens in our laboratories have been made by Mr. Allan Brooks of Okanagan Landing, Mr. Clyde Todd of the Carnegie Museum, and others; while the art department of the Public School system has borrowed many specimens for use in their classes. Numerous public and normal school teachers have applied to the museum for information, and many inquiries of like nature from all parts of the Dominion have been answered by mail.

Other institutions have extended to us the courtesies of their collections and staffs of specialists. Mr. Andrew Halkett of the Marine and Fisheries Department was of great aid and assistance in our examination of the fish contents of cormorant stomachs. Dr. A. G. Ruthven, of the University of Michigan, kindly made several reptile determinations for us and Mr. Harry Oberholser of the U.S. Biological Survey, examined and compared with the series in the cabinets of that institution our great horned owls and hairy woodpeckers and pronounced with authority upon them.

Dr. H. W. Henshaw, chief of the United States Biological Survey, loaned us a valuable series of Blue Grouse for comparison with our own by means of which we established the differentiation of the new sub-species before mentioned. To these gentlemen and the institutions they represent I wish to extend thanks for these courtesies.

The number of accessions for 1913 has been fewer than in previous years, but they have been of high average quality and our collections have been enriched with many desirable specimens filling numerous gaps in our series.

Among the most notable of the accessions is one composed of some 713 specimens, obtained by purchase. This consists largely of extra-limital material of peculiar interest to Canadian ornithology such as European and southern types of forms allied to Canadian varieties. In obtaining these we are grateful to Mr. J. H. Fleming, whose active efforts and advice were of great assistance to us in selecting them.

The results of our Chaleur Bay expedition are particularly rich in the larger water bird specimens and we secured series in all summer plumages of many interesting species and many colour sketches of their fading soft parts. The number of specimens is not large, but taking into consideration their character, the results are most satisfactory.

From other divisions of the Geological Survey, the usual quota of specimens have been received. Notable amongst them is a collection of some seventy butterflies made by F. J. Barlow who was asistant to D. D. Cairnes in the Yukon. These are now in process of examination and determination by the officials of the Entomological Branch of the Department of Agriculture.

M. Y. Williams brought in some interesting material from southern Ontario and the Bruce peninsula, Ontario.

By arrangement with the Department of Marine and Fisheries the ornithological specimens resulting from the voyage of the "Arctic," Captain Bernier, 1909, were secured for our collections. These include 28 bird skins and 4 sets of eggs taken mostly about Winter harbour, Melville island. They have already been formally reported upon in the official report of the voyage, but it is with considerable satisfaction that I am able to say that they are now among our collections and available for further examination and study.

Another valuable accession to which I desire to call particular attention is from the Canadian Arctic expedition, collected by R. M. Anderson and F. Johansen, mostly on the Arctic coast of Alaska in the neighbourhood of their headquarters at Collinson point and en route from Teller, Alaska, consisting of birds, mammals, and insects.

With the specimens of terrestrial zoology, in this lot are also extensive collections of marine life: foraminifera, marine shells, fish, etc., that, though the property of the Naval Service Department, are temporarily stored in our halls.

It will be seen by the reports from the officers of the expedition that these specimens do not constitute the entire collections made by the party, but that more is awaiting transportation.

Accessions, 1914.

By the Staff of the Natural History Division.

14- 2. By C. H. Young.—

32 bird skins, from England and Scotland, catalogue Nos. 7072-7103.

14-16. By Museum expedition—Museum staff, P. A. Taverner, C. H. Young, Frank Hennessey at Percé, Gaspe, and Magdalen islands, Quebec and Miscou island, N.B.,

May to August.—

- 376 bird skins, catalogue Nos. 7254-7629.
- 8 sets bird eggs and nests, Nos. 986-993.
- 2 mammals (*Sciurus* and *Zapus*), Nos. 2361-2362.
- 14 reptiles and batrachians, Nos. 576-589.
- 3 lots fish, Nos. 1067-1069.
- 1 crustacean (lobster), No. 1183.
- 230 bird stomachs.
- 125 photographs, 12 autochromes, 30 water coloured plates. Insects not catalogued; group accessories, etc.

14-17. By Museum expedition, Francis Harper, C. Camsell, Athabaska and Great Slave Lake expedition, May to October.—

- 93 birds, catalogue Nos. 7630-7721 and 7775.
- 22 mammals, catalogue Nos. 2366-2387.
- 25 reptiles and amphibians, catalogue Nos. 590-614.
- 53 lots fish, catalogue Nos. 1014-1066.
- Insects not catalogued.
- Over 450 photographs.
- For details see preliminary report following.

14-20. By preparation department—C. L. Patch, near Ottawa.—
20 birds, skins and mounted specimens, catalogue Nos. 7722-7751, and 7984-7985.
8 sets bird's eggs and nests, catalogue Nos. 998-1005.
1 mammal skin (*Sciurus*), catalogue No. 2468.
Group accessories.

14-50. By Canadian Arctic expedition, R. M. Anderson and F. Johansen, Arctic Alaska coast, June, 1913, to August, 1914.—
208 bird skins, catalogue Nos. 7776-7983.
77 mammal's skins (for details see list in preliminary report following), catalogue Nos. 2389-2465.
Insects, lepidoptera, hymenoptera, coloptera, etc.

By Members of the Geological Staff.

14-12. By M. Y. Williams, Bloomfield, Ont., April 10, 1914.—
Red Squirrel skin and skull, catalogue No. 2357.

14-26. By M. Y. Williams, Guelph, Ont., and Bruce peninsula.—
7 bird skins, catalogue Nos. 7754-7761.
1 mammal, No. 2388.

14-49. By D. D. Cairnes, collected by F. J. Barlow.—
71 lepidoptera, between Whitehorse and Lake Kluane, Y.T., not catalogued. Being determined by the Entomological Branch of Department of Agriculture.

By Transfer From Other Divisions.

14-49. From Palæontological Division.—
Small lot of Japanese shells.

By Presentation.

14- 1. By W. Taylor, Vancouver, B.C.—
1 Flying Squirrel, *S. a fuliginosus*, catalogue No. 2338.

14- 4. Royal Society of Canada.—
6 marine shells, *Salenomya borealis*, Portland, Me., not catalogued.

14- 6. By Dominion Parks Branch, Buffalo Park, Alberta.—
1 skeleton and hide of Mule Deer, from the zoo, catalogue No. 2356.

14- 7. By Mrs. Baxter, Ottawa.—
1 Hooded Merganser, 1 Brown Pelican, mounted, origin unknown, catalogue Nos. 7132-7133.

14-13. By J. P. William, Bloomfield, Ont.—
Yellow-bellied Sapsucker.

14-15. By Dominion Parks Branch.—
1 Ruffled Grouse and eggs, catalogue Nos. bird, 7136, egg 997.

14-18. By Dr. Mark McElhinney, Ottawa.—
1 Ruffled Grouse and eggs, catalogue Nos. bird, 7136, egg 997.

14-21. By W. Taylor, Vancouver, B.C.—
Shells, Savary island, B.C., not catalogued.

14-22. By M. P. Berrigan, Dawson, Y.T.—
Photograph of a catch of Wolf and Lynx from the Pelly river.

14-23. By Dominions Park Branch.—
2 Mute Swan skins, from captivity, catalogue Nos. 7752-7753.
Black bear, skin and skull, Laggan, B.C., 1911 or 1912. Catalogue No. 2360.

14-24. By W. Taylor, Vancouver, B.C.—
1 Pica skin and skull, catalogue No. 2363.

14-27. By H. H. Pittman, Red Deer, Alberta.—
1 set of eggs (Wilson Snipe?) catalogue No. 1006.

14-29. By C. H. Young, Ottawa.—
2 mounted spotted Sandpipers, Ottawa, Ont., catalogue Nos. 7250-7251.

14-30. By W. Taylor, Vancouver, B.C.—
1 Shrew skin (Sorex longicaudus), Vancouver district, elevation 7,300 feet, catalogue No. 2394.

14-31. By Eardly Young, Ottawa.—
1 Moleskin (fragment) (Parascolops breweri) near Ottawa, Ont., catalogue No. 2365.

14-32. By Mrs. Currie, 22 Regent street, Ottawa.—
1 Monkey in flesh (sp.?) catalogue No. 2469.

14-33. By Mr. Drummond, Ottawa.—
Poplar Wood, Beaver gnawing, not catalogued.

14-35. By R. T. Meredith, Quyon, Quebec.—
Great Gray Owl in flesh, catalogue No. 7763.

14-36. By A. G. Lawrence, Winnipeg, Man.—
Photo of Yellow-throated Vireo and nest near Winnipeg.

14-37. By Ottawa.—
1 Broad-winged Hawk in flesh, catalogue No. 7764.

14-48. By C. H. Miller, Ottawa.—
1 Live Acadian Owl, photographed and freed.

14-51. By Mr. Garland.—
1 Hawk Owl in flesh, catalogue No. 7986.

14-52. By H. Harper and J. H. Blakeley, Miscou island, N.B.—
2 sets of Great Blue Heron eggs, catalogue Nos. 1008, 1009.

14-53. By M. Y. Williams, Ottawa.—
1 Varying Hare, skin and skull, Ottawa, Nov. 1912, catalogue No. 2466

14-54. By Stewart Criddle, Treesbank, Man.—
1 Canada Goose in flesh, catalogue No. 7987.

By Purchase.

14- 9. From Ward's Natural Science Establishment.—
1 California Condor, catalogue No. 7131.

14- 8. From Dr. Max. M. Peet, Philadelphia, Penn.—
2 Kirkland Warblers, catalogue Nos. 7134, 7135.

14-10. From Ward's Natural History Establishment.—
113 bird skins extralimital, various dates and localities, catalogue Nos. 7137-7249.

14-11. From Albert Gardner, Pelee point, Ont.—
1 Barn Owl, Pelee point, Dec., 1913, catalogue No. 7249.

By Exchange.

14- 3. With Department of Marine and Fisheries.—
28 bird skins, catalogue Nos. 7103-7130.
4 sets birds eggs, catalogue Nos. 981-983.
These collected on the Voyage of the *Arctic*, 1903-1904, Captain Bernier in command, collected by Frank Hennessey, mostly about Winter harbour, Melville island, Franklin.

14- 5. With U. S. Biol. Survey, Washington.—
1 Marmot skin and skull, catalogue No. 2340.

Chaleur Bay Field Work, 1914.

(P. A. Taverner.)

Accompanied by C. H. Young I left Ottawa, May 18, and arrived at Miscou island May 21. We made camp near the mouth of Landry river near Miscou Harbour post-office, on the inner shore facing Shippigan island. From here we worked the woodlands and neighbouring shores and made side trips to Miscou point, the northeast corner of the island, and Wilson point, the southeast extremity, during the course of the work examining all the principal ecological conditions of the island.

Birds as a whole were very shy and difficult to find. On the " Barrens " work was hard and not very remunerative. Contrary to expectations the extensive mud flats on the shore nearby our headquarters were not productive of many waders but report said they occupied the outer sandy shores of the island in great numbers. Our trip to Wilson point was delayed by bad weather; we, therefore, missed these birds almost entirely.

We left Miscou island June 17 and arrived at Percé, on the opposite shore of Chaleur bay, on June 21. Here we spent most of our time on water birds, working the shores in either direction thoroughly and the fields and woodlands behind less intensively. The migrations, at this time, were about over, the land birds had settled down to their summer quietness and were difficult to find.

July 1 to 8 we camped on Bonaventure island, making an intensive study of conditions on the famous sea-bird nesting ledges of its outer or seaward face. July 21 we removed to Gaspe basin, where in the comfortable quarters courteously furnished us by Mr. Chas. Lindsay, Superintendent of the Dominion Fish Hatchery there, we spent two weeks investigating the food habits of the Double-crested Cormorant, in relation to the salmon interests.

August 10, we left Gaspe and on the invitation of Commander Wakeham of the Fisheries Service, made a flying trip to the Magdalen islands on the Fisheries' steamer *Princess.* Our objective point was Bird rock, but, on account of the state of war, orders from the Naval authorities caused our return without reaching our destination. We had about three hours on Amherst island, however, which we used to advantage and returned to our old quarters at Percé, August 12. There we made a general study of late seasonal conditions and finished up our incomplete work. We returned to Ottawa on August 20.

During this work we collected 376 bird skins, preserving the stomachs of the birds for economic study. The collection included about 30 cormorants, several nests and eggs, a few small mammals, a fair number of insects, a few reptiles and amphibians, and a good series of photographs, showing nesting and physical conditions of the localities visited. A full report on the seasons work is now in preparation.

Of my assistants I can hardly speak too highly. Mr. Young conducted his work with his usual energy and resourcefulness and to Frank Hennessey, who joined us before we left Miscou, we were indebted for a great number of interesting and accurate water colour sketches of the soft and fading parts of birds. Upon his return to Ottawa he painted a background for a lobster group, now under construction, in a very satisfactory and creditable manner.

For further details of collections see accession 14-17 in previous accession list.

The Athabaska-Great Slave Lake Expedition, 1914.

(Francis Harper.)

As field naturalist of an expedition sent by the Geological Survey to Great Slave lake, under the leadership of Charles Camsell, the writer spent the season of 1914, from May to October, in making biological investigations in the provinces of Alberta and Saskatchewan, and in the Mackenzie district.

The territory covered during the season may be briefly indicated as follows: leaving Athabaska Landing on May 19, the expedition proceeded by means of one of the river scows down the Athabaska, and reached its mouth on June 2. I spent the following week on the marshy delta of the Athabaska, and two more weeks at Fort Chipewyan, where final preparations were made for the canoe traverse to Great Slave lake. On June 24 the traverse party departed from Fort Chipewyan in tow of a steamer, and on the following day arrived at Charlot river on the north side of Lake Athabaska. From this place we began portaging on June 29, and passing through a series of five small lakes, reached Tazin lake on July 6. Following the course of its outlet, the Tazin river, we arrived at Hill Island lake on July 14, and at the junction of the Tazin and Taltson rivers, on July 29. We proceeded down the Taltson river reaching Tsu lake on August 6, the junction with Hanging Ice river on August 10, and Great Slave lake on August 15. We followed the south shore of the lake, and came to Fort Resolution on August 21. Ten days (August 26 to September 4) were spent in paddling up the Slave river to Fort Smith. From this post, through the courtesy of A. J. Bell, the Government agent, and of Peter McCallum, the Government buffalo guardian, I was enabled to make a six-days horseback trip into the wood buffalo country on the south. From Smith Landing our party made the outward journey with as few stops and delays as possible, reaching Fort Chipewyan on September 16, Fort McMurray on September 22, and Athabaska Landing on October 10.

For courtesies shown and for assistance of various kinds given during the course of the expedition, I desire to express my appreciation and indebtedness to Thomas McClelland, of Fort McMurray; to Sergeant Mellor, in charge of the Royal Northwest Mounted Police post at Fort Chipewyan, and to E. B. Dennis and Colin Fraser, of the same place; to H. W. Jones, of Fort Resolution; to A. J. Bell, Peter McCallum, and Robert S. Salmon, of Fort Smith; and to Stephens L. MacMillan, who, in addition to his duties as canoeman, performed faithful and efficient service as my field assistant throughout the season.

BIOLOGICAL CONDITIONS.

Since the biological conditions along the Athabaska and Slave rivers have been investigated by other naturalists, notably by Edward A. Preble[1], in recent years, this summary report will be devoted primarily to the previously unexplored region traversed between Lake Athabaska and Great Slave lake. The greater part of this region, as far as the junction of the Taltson and Hanging Ice rivers, consists of rugged rocky hills. Near Black bay they rise to a height of probably 700 or 800 feet above the level of the lake, but northward the relief becomes much less pronounced. The rivers are marked by numerous rapids and falls. In many places, especially on the sides and summits of the hills, the soil is thin or entirely wanting; but the rocks are everywhere clothed with lichens and mosses, and the scantiest covering of earth suffices to furnish the jack pine (*Pinus divaricata*) with a foothold. While the timber on many of the hills is sparse and of medium size, the better conditions of soil and moisture along the valleys and in the muskegs enable the trees to attain a larger size and a heavier growth. In addition to the jack pine, the trees of this region are the white spruce (*Picea canadensis*), black spruce (*Picea mariana*), tamarack (*larix laricina*), quaking aspen (*Populus tremuloides*), balsam poplar (*Populus balsamifera*), willow (*Salix* sp.), canoe birch (*Betula papyrifera*), dwarf birch (*Betula glandulosa*), and alder (*Alnus* sp.). Unfortunately a large part of the country appears to have been swept time and again by forest fires, which the Indians set in order to temporarily improve the hunting.

The valley of the Talston river, from its confluence with Hanging Ice river to Great Slave lake, presents an aspect very different from that of the more elevated country on the east. It is comparatively level and very well timbered, and for long distances no rock outcrops are seen. There are certain noticeable changes in the faunal and floral conditions, which are similar to those in the adjacent part of the Slave River valley.

The rugged part of the region is rather poor in game, especially in the larger species, except in the winter, when the Barren Ground Caribou move south into the wooded country. The following mammals were noted, collected, or otherwise ascertained to occur along the route of the traverse: Black Bear (*Ursus americanus*)[2], Grey Wolf (*Canis occidentalis*), Red Fox (*Vulpes alascensis*), Mink (*Mustela vison*), Otter, (*Lutra canadensis*), Lynx (*Lynx canadensis*), White-footed Mouse (*Peromyscus maniculatus*), Red-backed Mouse (*Evotomys gapperi*), Muskrat (*Ondatra zibethica*), Red Squirrel (*Sciurus hudsonicus*), Beaver (*Castor canadensis*), Varying Hare (*Lepus americanus*), Moose (*Alces americanus*), Barren Ground Caribou (*Rangifer arcticus*), and Woodland Caribou (*Rangifer caribou*).

The bird life of this region is not particularly abundant, neither in species nor individuals. Of the 85 species noted between June 25 and August 18, the following may be considered the commoner or more characteristic summer residents: Common

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[1] See N. A. Fauna No. 27. A Biological Investigation of the Athabaska-Mackenzie Region. By Edward A. Preble, Washington, 1908.

[2] Since the mammalian material collected has not yet been critically examined no attempt is made here to indicate the sub-specific relationships of any of the mammals mentioned.

Loon (*Gavia immer*), Herring Gull (*Larus argentatus*), Short-billed Gull (*Larus brachyrhynchus*), American Merganser (*Mergus americanus*), Red-breasted Merganser (*Mergus serrator*), Surf Scoter (*Oidemia perspicillata*), Spotted Sandpiper (*Actitis macularia*), Hudsonian Spruce Grouse (*Canachites canadensis canadensis*), Northern Bald Eagle (*Haliætus leucocephalus alascanus*), Duck Hawk (*Falco peregrinus anatum*), Pigeon Hawk (*Falco columbarius columbarius*), Northern Flicker (*Colaptes auratus luteus*), Night Hawk (*Chordeiles virginianus virginianus*), Phoebe (*Sayornis phoebe*), Canada Jay (*Perisoreus canadensis canadensis*), Northern Raven (*Corvus corax principalis*), Rusty Blackbird (*Euphagus carolinus*), Redpoll (*Acanthis linaria linaria*), Western Chipping Sparrow (*Spizella passerina arizonæ*), Slate-coloured Junco (*Junco hyemalis hyemalis*), Lincoln's Sparrow (*Melospiza lincolni lincolni*), Cliff Swallow (*Petrochelidon lunifrons lunifrons*), Barn Swallow (*Hirundo erythrogastra*), Tennessee Warbler (*Vermivora peregrina*), Myrtle Warbler (*Dendroica coronata*), Blackpoll Warbler (*Dendroica striata*) Grinnell's Water-thrush (*Seiurus noveboracensis notabilis*), Olive-backed Thrush (*Hylocichla ustulata swainsoni*), Hermit Thrush (*Hylocichla guttata pallasi*), and Robin (*Planesticus migratorius migratorius*).

The Leopard Frog (*Rana pipiens*) and the Northern Wood Frog (*Rana Cantabrigensis*) were the only amphibians noted between Lake Athabaska and Great Slave lake.

The following fishes were recorded on the traverse: two species of Suckers (*Catastomidae*), Whitefish (*Coregonus* sp.), Inconnu (*Stenodus mackenzii*), Lake Trout (*Cristivomer namaycush*), Pike (*Esox lucius*), Nine-spined Stickleback (*Pygosteus pungitius*), Wall-eyed Pike (*Stizostedion vitreum*), Burbot (*Lota maculosa*), and a number of species not yet fully determined, including a Minnow and a Sculpin.

Our route from Lake Athabaska to Great Slave lake was found to lie almost entirely within the Canadian zone, although the United States Biological Survey's Fourth Provisional Zone Map of North America, prepared by Merriam, Bailey, Nelson, and Preble in 1910, indicates the Hudsonian zone as covering most of the region. Only at Hill Island lake and vicinity was a pronounced Hudsonian element noticed in the fauna. This lake is on the approximate boundary between the two zones, as far as can be judged by the occurrence there, at the breeding season, of such typical Hudsonian species as the Tree Sparrow (*Spizella monticola monticola*) and the Grey-cheeked Thrush (*Hylocichla aliciæ aliciæ*), in association with such Canadian zone species as the Western Chipping Sparrow (*Spizella passerina arizonæ*), Swamp Sparrow (*Melospiza georgiana*), Orange-crowned Warbler (*Vermivora celata celata*), Olive-backed Thrush (*Hylocichla ustulata swainsoni*), and Hermit Thrush (*Hylocichla guttata pallasi*).

The Wood Buffalo.

On the journey into the country of the Wood Buffalo (*Bison bison athabascæ*), I was accompanied by Peter McCallum, who has been the buffalo guardian for several years. We rode for a distance of approxomately 40 miles in a general southerly direction from Fort Smith, and during about the last 15 miles crossed a slightly elevated plateau, known as Salt mountain. This plateau is the range of the buffaloes, and here were their signs in abundance—tracks, trails, wallows, dung, and a salt lick. Some of the trails, especially those converging towards the salt lick, had been worn 6 inches into the ground, and were kept open by constantly passing feet. The lick itself is an irregular area, approximately 100 yards long and 30 yards wide, and appeared to have been trampled over by scores of animals. Here, on September 11, we saw one of them.

According to McCallum, the buffaloes are divided into main herds or groups, and number at present about 500 individuals. During the winter the herd, whose territory we entered, ranges south to Peace river. The other herd is found northwest of Fort Smith in the region of the Little Buffalo river.

In the last few years, since the appointment of a guardian, the buffaloes have probably been molested but little by the Indians. It is doubtful if many are killed by the wolves, and it seems that the herds have increased of late. But there is a possible danger from human encroachment that cannot be overlooked; settlements and a railway are rapidly pushing into the Peace River valley. The setting aside of the buffalo ranges as a permanent reservation, as well as the maintenance of a warden service, seems essential to the continued existence of this noble animal in a wild state.

Ornithological Records.

Some of the more interesting ornithological records of the season were the following.

Short-billed Gull. *Larus brachyrhynchus.* This species was found nesting near Charlot river, on Lake Athabaska, and was noted frequently on the traverse to Great Slave lake. The breeding ranges of this and the next species were previously known to extend south in this region only as far as Great Slave lake and the lower part of Slave lake.

Arctic Tern. *Sterna paradisæa.* Numbers of Arctic Terns were noted from June 26 to 30 near Charlot river on Lake Athabaska, where they were presumably breeding.

Hutchin Goose. *Branta canadensis hutchinsi.* On August 3 a flock of about ten geese of this subspecies was seen on Taltson river about 2 miles above Tsu lake. Two adults and four young ones were taken. The young, though well fledged, were evidently still unable to fly, and had doubtless been reared at no great distance from that place. The record is of interest in that the birds were hundreds of miles from their usual breeding haunts on the barren grounds.

Whooping Crane. *Grus americana.* It is a pleasure to record several recent occurrences of this magnificent and nearly extinct species. I saw photographs of two specimens which had been taken on the lower Athabaska river on or about September 13, 1913; and in Edmonton I saw one of these two birds, which had been mounted. I also received quite reliable information concerning the presence of a single bird on April 20, 1914, and of six birds, including young of this year, in the last week of August, 1914, in a certain locality near which we passed during the season. The birds were believed to have nested there.

Stilt Sandpiper. *Micropalama himantopus.* In view of the general scarcity of the Stilt Sandpiper, its occurrence in large numbers on the Athabaska delta during the spring migration is of interest. Here, on June 4 and 6, the birds were observed feeding in flocks at a very shallow muddy lake; and on the latter date a careful estimate made their numbers approximately 700 or 800. The species was again noted on August 27 on the lower Slave river, where two small flocks were seen.

Yellow-bellied Flycatcher. *Empidonax flaviventris.* On July 20 and 21 three Yellow-bellied Flycatchers, including a young bird of that year, were discovered on the Tazin river below Hill Island lake. On the latter date the young one was collected. A single bird was noted in the same locality on the following day, and another further down the river on July 27. Still another was heard on August 15 on the Taltson river about 20 miles from its mouth. These appear to constitute the only records of the species in the Mackenzie River district.

Rock Wren. *Salpinctes obsoletus obsoletus.* A Rock Wren was seen at Fort Chipewyan on June 12 and 17. The bird frequented the rocky ledges about the Roman Catholic mission, and made use of the chimney of a sawmill as a singing perch. Apparently the nearest locality in which the species has previously been recorded is west central Alberta.

Collections.

The collections for the season numbered approximately as follows: 22 mammals, 93 birds, 1 reptile, 26 amphibians, 105 fishes, and several hundred each of insects and plants. Over 450 photographs, including 13 autochromes, were taken; they are illustrative, for the most part, of the topography, vegetation, fauna, and natives of the country.

CANADIAN ARCTIC EXPEDITION, 1913-14.

(R. M. Anderson.)

During most of the year the routine work of the southern party of the expedition occupied a great part of my time. Since late in the winter the whole of the business end of the expedition, including the apportionment of supplies and equipment for three vessels, has devolved upon me; this is due to the complications resulting from Mr. Stefansson's separation from the *Karluk*, and his subsequent departure upon an ice trip. Nothing has been heard of him since early in April. Consequently, the time for field work and the preparation of specimens was limited.

Some collections were made around Teller, Alaska, in July and August, 1913, and some on the voyage to Collinson point. A few specimens were secured around Collinson point in the autumn, and a few trips up the Sadlerochit and Hulahula rivers in the autumn and spring. A trip was made to the west edge of the Mackenzie delta in the spring by sled, and an early summer trip to Flaxman island.

Skins to the number of 289 were collected—212 birds and 77 mammals—and packed for shipment. About thirty more are stored to be shipped later. A small collection of large bird skins from the Cape Bathurst regions were purchased and stored to be shipped later. In the vicinity of Collinson point, I secured nests and eggs of most of the breeding birds of the region, but have not had time to pack them securely enough to risk their shipment.

With the southern party in more systematic running order and all the men more used to work in the Arctic, I hope to be in a position to do enough zoological work to justify myself as a scientific man in being here; this I have hardly been able to do during the past year.

In other branches of biology Mr. Johansen has carried on quite extensive researches; particularly in entomology and botany, although freshwater life and marine biology have also received some attention.

Preliminary List of Specimens Collected by R. M. Anderson, 1913-1914.[1]

Birds.

1. Yellow-billed Loon. *Gavia Adamsii.*
   ♀ ad July 8, Camden bay, Alaska.
2. Pacific ? Loon. *Gavia*, sp?
   ad ♂ and ♀ July 1 and 4, Collinson point and Flaxman island.
3. Red-throated Loon. *Gavia stellata.*
   ad ♀ ad ♂♂ June 10 and July 3 and 4.
   Canning river and Collinson point, Alaska.

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[1] In view of the fact that it will probably be some time before a complete and careful report can be made upon the results of the work of the Canadian Arctic Expedition, it seems desirable that a passing preliminary notice of the constitution of this collection, so far received, should be made. It must be understood, however, that time and proper courtesy to the collector have prevented a careful and critical study of this material and the determinations, especially the subspecific ones, are, therefore, only such as could be arrived at from a cursory examination, by the writer.

4. Mandt Guillemot. *Cepphus mandti.*
ad ♀ changing plumage Aug. 1, Teller, Alaska.

5. Pallas Murre. *Uria lomvia arra.*
ad ♀ and ad ♀ changing plumage Aug. 15 and 27, Point Barrow

6. Pomarine Jaeger. *Stercorarius pomarinus.*
♂ ♂ ♀ light phase, Aug. 21, Point Barrow, June 4 and 7, Collinson point.

7. Parasitic Jaeger. *Stercorcarius parasiticus.*
♀ ♀ light phase, Aug. 23, Point Barrow, July 1, Collinson point. ♀ ♀ dark phase, Aug. 21 and 23, Point Barrow.

8. Long-tailed Jaeger. *Stercorarius longicaudus.*
♂ June 18, Collinson point, light phase.

9. Pacific Kittiwake. *Rissa tridactyla pollicaris.*
ad ♂♂ ♀♀ jv ♂♂ ♀♀ Aug. 21-30, Point Barrow.

10. Glaucous Gull. *Larus hyperboreus.*
ad ♀♀ July 6, Camden bay and Aug. 28, Point Barrow.
jv ♀♀♀♀ Aug. 27 to Oct. 8, various points on the Arctic coast.

11. Short-billed Gull. *Larus brachyrhunchus.*
jv ♀ Sept. 8, Collinson point.

12. Sabine Gull. *Xema sabini.*
ad ♀ Aug. 25, Point Barrow, jv ♀ Sept. 19, Collinson point.

13. Arctic Tern. *Sterna paradisæa.*
ad ♀♀ Aug. 23, Point Barrow, July 3, Camden bay.
jv ♂ Aug. 6, Teller, Alaska, Fledging (Sex?) Aug. 23, Point Barrow.
Nestling ♀ ? Aug. 6, Teller.

14. Red-breasted Merganser. *Mergus serrator.*
♀ in changing plumage, June 30, mouth of Canning river.

15. Pintail. *Dafila acuta.*
jv ♂♂ ♀♀♀♀♀, Sept. 8 and 16, Collinson point and Sadlerochit river.

16. Old Squaw. *Harelda hyemalis.*
ad ♂♂ winter plumage, June 5 and 20, Collinson point.
ad ♂♂♂ changing plumage, June 5, Oct. 2, Collinson point.
jv ♂♂♂ Aug. 23, Oct. 2, Point Barrow and Collinson point.
♀♀ June 18 and Oct. 2, Collinson point.

17. Steller Eider. *Polysticta stelleri.*
ad ♂♀ June 15, Barter island.

18. Spectacled Eider. *Arctonetta fischeri.*
ad ♂♂♂♂ ♀♀♀ June 15, Barter island and July 6, Camden bay.

19. Pacific Eider. *Somateria v-nigra.*
ad ♂♂ ♀ June 30, mouth of Canning river and July 6, Camden bay.
♀ changing plumage, Sept. 23, Collinson point.

20. King Eider. *Somateria spectabilis.*
♂ data lost probably Oct., coast of Alaska.
♀♀ May 12 and Aug. 27, Point Barrow.

21. Surf Scoter. *Oidemia perspicillata.*
ad ♂ July 5, Collinson point.

22. White-fronted Goose. *Anser albifrons gambeli.*
♂♀ Barter island, June 15.

23. Hutchin Goose. *Branta canadensis hutchinsi.*
ad ♂ June 15, Barter island.

24. Black Brant. *Branta nigricans.*
♂♂♂♂♂ ♀ Sept. 8 and 13 and June 3.

25. Red Phalarope. *Phalaropus fulicarius.*
9 ♂s and 7 ♀s Aug. 4, Teller and Sept. 12-13, Collinson point. All in juvenile or autumn dress but one, ♂ Aug. 4.

26. Northern Phalarope. *Lobipes lobatus.*
    jv ♂♀ Aug. 4, Teller.
27. Pectoral Sandpiper. *Pisobia maculata.*
    ♂♂ May 31, June 14, Collinson point. The breast skin on these birds, especially on the last one, seems much stretched and the feathers consequently thinner and scattered. This may be, and probably is, a seasonal character, acquired when the bird is displaying and strutting as described by Mr. E. W. Wilson.
28. White-rumped Sandpiper. *Pisobia fuscicollis.*
    ♂ May 31, Collinson point.
29. Baird Sandpiper. *Pisobia bairdi.*
    ♂♂ ♀ May 31 to June 17. downy young, July 11, Collinson point.
30. Red-backed Sandpiper. *Pelidna alpina sakhalina.*
    ♂ ♀♀ June 2-July 7. Collinson point and Camden bay.
31. Semipalmated Sandpiper. *Ereunetes pusillus.*
    ♂♀ May 31 and 4, downy young, July 7, Collinson point.
32. Western Sandpiper. *Ereunetes mauri.*
    ♀ ? fledging, just flying, Aug. 6, Teller. Though barely out of nesting down and not yet fully grown in size, the rufus on the back is perfectly characteristic of the species.
33. Hudsonian Curlew. *Numenius hudsonicus.*
    ♀ June 18, Collinson point.
34. Black-bellied Plover. *Squatarola squatarola.*
    One, sex ?, worn, bleached plumage, June 2, Collinson point.
35. American Golden Plover. *Charadrius domimicus.*
    ♂ High plumage, June 2, Collinson point.
36. Semipalmated Plover. *Ægialitis semipalmata.*
    ♂ June 1, Collinson point.
37. Ruddy Turnstone. *Arenaria interpres morinella.*
    ♂♀ May 31 and June 9, Collinson point. Three downy young, in alcohol.
38. Willow Grouse. *Lagopus lagopus.*
    30 specimens in summer, winter, and changing plumage Sept., Oct., April, and June, Collinson point and Endicott mts.
39. Rock Ptarmigan. *Lagopus rupestris.*
    11 specimens in summer, winter, and changing plumages, June 1–July 7, Collinson point.
40. Rough-legged Hawk. *Archibuteo lagopus sancti-johannis.*
    ♀♀ Sept. 11 and 12, Collinson point in common ochraceous plumage, with dark abdominal bands.
41. Gray Gyrfalcon. *Falco rusticolus rusticolus.*
    ♀ Sept. 11, Collinson point.
42. Duck Hawk. *Falco peregrinus anatum.*
    ad ♂♀ Collinson point, July 17.
43. Short-eared Owl. *Asio flammeus.*
    ♂ ♀♀ Collinson point, May 30 to June 3.
    Sex ? Barter island, May 29.
44. Snowy Owl. *Nýctea nýctea.*
    ad ♂ ♂♂ ♀ Arctic coast, Alaska, Nov. 14 and April to June.
    ♂s immaculate white ♀ moderately barred.
45. Alaska Jay. *Perisoreus c. fumifròns.*
    ♀ Endicott mts., Alaska, April 16.
46. Red Poll. *Acanthis sp?*
    ad ♂♀ Collinson point, June 1, fledging, no data.
47. Snow Bunting. *Plectophenax nivalis nivalis.*
    ♂♂ ♀ Northern Alaska to coast, Aug. and Sept. fledging, Collinson point, July 12.

48. Lapland Longspur. *Calcarius lapponicus lapponicus.*
  ♂♂♂ ♀♀♀♀ Teller to Collinson point, Aug., Sept., and June.
49. Tree Sparrow. *Spizella monticola.*
  ♂ Teller, Aug. 6.
50. Fox Sparrow. *Basserella iliaca*, subsp?
  ♀♀ Teller, Aug. 3 and 5.
  Sex ? no data.
51. Yellow Wagtail. *Budytes flavus* subsp?
  ♂ Teller, Aug. 3.
52. Pipit. *Anthus rubescens.*
  ad ♂♀ near Collinson point, June 17.
  jv ♂♀ ? Teller, Aug. 3 and 6.

Mammals.

All from Collinson point and points along the Arctic coast of Alaska.

16. *Cittellus,* Aug., Sept., and Oct.
20. *Microtus,* Aug., Sept., Oct., and March.
8. *Lemmus,* Sept., Nov., March, May, June.
8. *Vulpes, (lagopus?)* Sept., Oct., Dec., Jan., and Feb.
1. *Vulpes, (fulvus?)* Nov. 17.
3. *Lepus,* Mackenzie delta, Jan.
4. *Putorius,* Winter, April, May, and June.
2. *Dicrostonyx,* Barter island and Collinson point, May, one fragment.
1. *Gulo,* weathered skull.
2. *Ursus* (*internationalis?*) cubs, without skulls, July.
1. *Ovibos,* weathered skull fragment, near Collinson point
1. *Odobenus,* weathered skull, Point Barrow.
1. *Canis,* weathered skull.

ENTOMOLOGY.

(C. Gordon Hewitt, D.Sc., Dominion Entomologist, Honorary Curator.)

On April 1, 1914, I was appointed Honorary Curatory of Entomology in the National Museum by the Honourable Mr. Louis Coderre, Secretary of State and Minister of Mines, with the approval of the Minister of Agriculture. The arrangement this appointment involves will prove of great value in co-ordinating the entomological work of the Government and in preventing undesirable duplication. The entomological branch of the Department of Agriculture has formed, as a result of its work, a nucleus of a national collection of insects. This collection is constantly being increased. It is intended to transfer the major portion of this collection to the National Museum where it will be permanently housed. With the collection that the Museum of the Geological Survey has acquired by purchase and has secured by the efforts of its members an excellent foundation has been laid for a collection of the insects of Canada. It is proposed to appoint an assistant to look after the collections in the museum and the various officers of the Entomological Branch of the Department of Agriculture will undertake the work of determination in the various orders in which they specialize.

During the year the museum purchased the private collection of Mr. J. D. Evans, of Trenton, Ont., which is of special interest on account of the exceptionally fine series of well-mounted *Coleoptera* it contains, constituting undoubtedly the best collection of this order of insects in the Dominion.

Arrangements were effected to have entomological collections made by the Canadian Arctic expedition. Specimens have already been received and the reports indicate that the indefatigable efforts of Mr. Johansen, who is making the collections of insects, will result in very valuable additions to the collection and to our meagre knowledge of the insects of the Arctic region.

It has been decided to have the entomological collection stored in drawers similar in design to those used in the United States National Museum. These drawers will be kept in steel cabinets each to hold 50 drawers. Our thanks are due to Mr. Crawford, Curator of Insects in the United States National Museum, for his assistance in the matter of securing the designs of the drawers and cases. It is expected that these drawers will be ready for use early in 1915.

During the year a beginning was made in the matter of permanent public exhibits and a series of enlarged models was made to our order and placed in the entrance hall of the museum. These models represent the adults and stages in the life-histories of the following insects: the House-fly, Mosquito, and Black-fly. It is planned to arrange in one of the exhibition halls an educational exhibit illustrating the various aspects of entomology in such a manner as to serve as a guide to a knowledge of insects.

CANADIAN ARCTIC EXPEDITION.

(Fritz Johansen.)

During our stay at Teller, 1913, I made rather extensive collections of and observations on the land and freshwater invertebrates there. The collected material has, together with a report, been sent from Teller to the museum at Ottawa.

During our stay at Teller, 1913, I made rather extensive collections of nad on a large scale, of the land and freshwater invertebrates and have had good success in rearing quite a few insects. At Collinson point, up the Sadlerochit river (November, 1913) at Demarcation point, Alaska (May, 1914) and at Longengevik west of Collinson point (June, 1914) considerable entomological work has been carried on. This biological investigation has now (as I suppose) been made, for the first time, in the American Arctic and very satisfactory results have been obtained. The collected specimens have been assembled at Herschell island to be sent to the museum at Ottawa.

DIVISION OF ANTHROPOLOGY.

(E. Sapir.)

STAFF.

In the course of the year Mr. F. H. S. Knowles received a permanent Civil Service appointment as physical anthropologist of the Anthropological Division of the Geological Survey. The Anthropological Division as at present constituted thus consists of three sections: Ethnology and Linguistics in charge of E. Sapir, Archæology in charge of H. I. Smith, and Physical Anthropology in charge of F. H. S. Knowles.

PART I.

ETHNOLOGY AND LINGUISTICS.

(E. Sapir.)

Museum.

Exhibits.

Owing to the lack of facilities for exhibition it has been impossible to add extensively to the exhibits as reported on for 1913, although there is more than enough museum material available for at least one other anthropological hall. Two temporary cases containing Montagnais specimens have been added to the Anthropological Hall. A number of striking objects of ethnological interest have been placed on top of the cases in addition to those already enumerated for 1913. These embrace a Labrador Eskimo kayak, a large double-face Nootka mask, a Haida image of an eagle, and a Haida house model. The Iroquois exhibit has been completely labelled. A special British Columbia basketry exhibit, chiefly from the Thompson River Indians, has been installed in the entrance hall of the museum.

Accessions of Ethnological Specimens.

Nearly 1,700 ethnological objects obtained either by gift, by purchase in the course of regular field work of the Division, or by purchase of material not directly obtained in connexion with field work, have been added in the course of the year to the collections of the museum.

The gifts embrace:

From P. Radin.—
  1 Ojibwa specimen.

From F. G. Speck, Philadelphia.—
  1 Abenaki specimen.
  1 pair beaded Sioux leggings.

From F. H. S. Knowles.—
  1 beaded Micmac bag.

The ethnological specimens obtained in the course of regular field work for the Survey are as follows:—

By E. Sapir.—
  83 Nootka specimens from Alberni, B.C.
  1 Coast Salish specimen from Alberni, B.C.
  1 Thompson River specimen from Spences Bridge, B.C.

By H. I. Smith.—
1 Micmac specimen from Indian island, N.S.

By C. M. Barbeau.—
56 Huron specimens from Lorette, Que.
1 Montagnais specimen from Lake St. John, Que.

By F. W. Waugh.—
18 Iroquois specimens from Six Nations Reserve, Ont.

By W. J. Wintemberg.—
1 Iroquois silver brooch from Hastings county, Ont.

By E. W. Hawkes.—
2 Greenland Eskimo specimens.
364 Labrador Eskimo specimens (including 1 kayak).
39 Central Eskimo specimens.
2 Naskapi specimens.

By W. D. Wallis.—
172 Sioux specimens from Manitoba.
2 Western Cree specimens from Manitoba.

By J. A. Teit.—
31 Thompson River specimens from Spences Bridge, B.C.
1 Lillooet specimen from British Columbia.
2 Shuswap specimens from British Columbia.
1 Chilcotin specimen from British Columbia.
2 Wenatchie (Washington) specimens.

By J. A. Mason (collected in 1913).—
1 Chipewyan specimen from Ft. Resolution.
30 Dogrib specimens from Ft. Rae (including 2 birchbark canoes)
40 Slave specimens from Ft. Rae and Ft. Providence.

By J. A. Mason.—
1 Nahanie specimen from Ft. Rae.

This embraces only part of the Athabaskan collections made by Dr. Mason in the summer of 1913, the rest of the material not having been received in 1914.

Ethnological specimens purchased in course of field work by members of the Geological Survey not connected with the Division of Anthropology are:—

By D. D. Cairnes.—
5 Athabaskan specimens from southwestern Yukon Territory.

Ethnological material purchased otherwise than in course of field work embraces:—

From G. A. Paul, Oldtown, Me.—
82 Malecite specimens.
2 Penobscot specimens.
46 Micmac specimens.

From James Paul, St. Mary, N.B.—
1 Malecite toboggan and harness.

From F. G. Speck, Philadelphia, Pa.—
57 Micmac specimens from Newfoundland.
2 Micmac specimens from Cape Breton.
2 Penobscot specimens from Oldtown, Me.
3Montmagnais specimens from near Hamilton inlet, Que.
1 Greenland Eskimo specimen.

29 Labrador Eskimo specimens.
1 Alaskan Eskimo specimen.
11 Iroquois specimens from Lewiston, N.Y.
4 Huron specimens from Lorette, Que.
1 Canadian Sioux specimen.
21 Abenaki specimens from Pierreville, Que.
1 Abenaki specimen from Oldtown, Me.

From F. G. Speck, Philadelphia, Pa.—
1 Ojibwa specimen from Timagami, Ont.
1 Coast Salish specimen from Georgia lake, B.C.
2 Nootka (Makah) specimens.
2 Athabaskan specimens from Yukon river, Alaska.

From L. Pereira, Ottawa.—
1 Cree fire-bag.

From R. N. Wilson, Stand Off, Alberta.—
2 Blackfoot shields.

From Simeon Gibson, Six Nations Reserve, Ont.—
8 Iroquois specimens.

From Louis Shotridge, Philadelphia, Pa.—
1 Chilcat blanket.

From K. M. Chapman, Santa Fé, N. M.—
48 Tlingit specimens from southern Alaska.

From Alfred Tremblay, Giffard, Que.—
32 Baffin island Eskimo specimens.

From A. B. Reagan, Nett Lake, Minn.—
6 Ojibwa birchbark records.

From Frank Williams, Alberni, B.C.—
7 Nootka specimens.

From S. H. Harris, London, England.—
46 Eskimo specimens.
39 West Coast specimens.
63 Plateau and Mackenzie Valley specimens.
2 Plains specimens.
6 Eastern Woodland specimens.

From Harley Stamp, Philadelphia, Pa.—
29 Malecite specimens from New Brunswick.

From Thomas Deasy, Massett, B.C.—
36 Haida specimens.

From C. Leden.—
8 Chipewyan specimens (including birchbark canoe).
50 Labrador Eskimo specimens.
145 Pardlamiut Eskimo specimens from Churchill (including kayak).

Photographic Work.

A considerable number of photographs of ethnological interest have been added to the files of the Division. The gifts embrace:

From the American Museum of Natural History, New York.—
20 photographs (1 Montagnais photograph, 13 Iroquois photograhs, 6 Malecite photographs) illustrating beadwork and moosehair patterns.

From F. G. Speck, Philadelphia, Pa.—
8 Montagnais photographs from Lake St. John.
8 Malecite photographs from Bar Harbour, Me.
33 Micmac photographs from Newfoundland.
1 Huron photograph.

From Peabody Museum, Cambridge, Mass.—
1 Malecite photograph of beaded coat.

From Royal Victoria Museum, Toronto University.—
2 Iroquois photographs of embroidery.

From W. E. Collinson, Prince Rupert, B.C.—
6 Haida photographs from Massett, B.C.

From T. Deasy, Massett, B.C.—
1 Haida photograph from Tow Hill, B.C.

From C. F. Newcombe, Victoria, B.C.—
18 Nootka photographs.

From J. A. Cox, Alberni, B.C.—
4 Nootka photographs.

The ethnological photographs taken by members of the anthropological staff and by the Photographic Department of the Museum embrace:

By E. Sapir.—
47 Nootka photographs from Alberni, B.C.

By H. I. Smith.—
4 Carrier photographs from Quesnel, B.C.

By C. M. Barbeau.—
29 Huron photographs from Lorette, Que.

By F. W. Waugh.—
27 Iroquois photographs from Six Nations Reserve, Ont.

By W. D. Wallis.—
109 Sioux photographs from Manitoba.
1 Western Cree photograph from Manitoba.

By J. A. Teit.—
175 Thompson River photographs from Spences Bridge, B.C.
4 Okanagan photographs from Spences Bridge, B.C.
3 Shuswap photographs from Spences Bridge, B.C.
3 Lillooet photographs from Spences Bridge, B.C.

By Photographic Department.—
6 Photographs of Malecite museum specimens.
3 Iroquois photographs.
1 Micmac photograph.

There have been purchased:

From the University of Pennsylvania, Philadelphia.—
50 Plates and prints of Huron and Iroquois specimens illustrating designs.

From the University of Toronto.—
75 Prints of the Warren lace collection, for comparative study of designs.

Phonograph Records.

Phonograph records received in the course of the year as a result of ethnological field work undertaken by the Survey embrace:

By E. Sapir, 25 Nootka records from Alberni, B.C.

By W. D. Wallis, 46 Canadian Sioux records from Manitoba.

J. A. Mason's extensive collection of Northern Athabaskan and other songs, and J. A. Teit's collection of Thompson River songs have not yet been received.

2 Nootka phonograph records were purchased from Frank Williams, Alberni, B.C.

Exchanges.

In exchange for 44 Dogrib, 1 Chipewyan, 1 Slave, and 1 Yellowknife photographs received from Dr. D. E. Wheeler, Buffalo, N.Y., the Geological Survey has forwarded to him 44 prints of some of its Dogrib photographs.

Field Work and Research.

In January and February, E. Sapir concluded a period of five months of field work, begun in the autumn of 1913, among the Nootka Indians of the west coast of Vancouver island. This was in continuation of field work carried on among the same Indians in 1910 (see Summary Report for 1910). The same tribes were investigated as in the previous field trip, namely the Ts'ish'a'ath and the Hopach'as'ath, at present living within a short distance of Alberni. Further material was obtained on the Nootka language, and a large series of Nootka texts dealing with mythology and various ethnologic topics was recorded. This text material, with the supplementary texts referred to below, covers about 1,250 pages of manuscript. Considerable information was obtained on social organization (types and inheritance of privileges, names, potlatches, seating at potlatches, and many other aspects of this subject), on religion (secret rituals, supernatural beings, religious beliefs), and on other ethnological matters. A number of ceremonies were witnessed and careful notes taken during their performance, the most interesting of these being a doctoring ceremony, known as Ts'ayek, that had not been performed among these Indians for many years past. A series of face paintings and other drawings were made by Indian informants, and valuable information on religion and ceremonials obtained in connexion with them. The Division now possesses over 200 distinct Nootka face paintings. Several phonograph records were made, chiefly in connexion with songs occurring in legends, and an ethnological collection made, chiefly of ceremonial objects. Instruction was given two of the more intelligent interpreters, Alex. Thomas and Frank Williams, in the phonetic recording of their own language. This proved of inestimable value, as in this way supplementary text material could be obtained from the Nootka Indians in the absence of the investigator. The nature of the supplementary material of this sort already received, will be indicated below. Mr. Sapir undertook in the course of the year a special investigation of the possible linguistic affiliation between the Athabaskan, Haida, and Tlingit languages, hitherto generally considered as forming independent stocks. The result of this investigation was the demonstration of the genetic unity of these three groups of languages. A paper on the "Na-dene Languages," embodying the results of this research, is well under way.

C. M. Barbeau took a brief trip to the Huron Indians of Lorette, whom he had visited several times in the past, for the purpose of obtaining a series of French Canadian tales current among these Indians. This was done primarily for the purpose of ascertaining what influence, if any, European folk-lore has exerted on the content and form of native mythology. Further ethnological collections were obtained at the same time. The greater part of the year was taken up in preparing for publication an extended paper on "Huron and Wyandot Mythology." This monograph is now completed.

F. W. Waugh spent a short period of time among the Iroquois Indians of Six Nations Reserve, Ontario, the work done in 1914 being in amplification of material previously obtained. Most of the time was taken up with medicine and ideas relating thereto, also with general Iroquois medical ideas and folk-lore. Some additional information was also obtained regarding foods and food preparation, games, tanning, and other handicrafts. A number of specimens were collected, some of them very old. A special feature of the trip was the taking of two Iroquois face masks, and three Iroquois head and shoulder casts, all on the living.

P. Radin continued his work among the Ojibwa of various parts of Ontario and adjoining regions of the United States, about a month being spent among the Northern Saulteaux of Ontario. The work among the Ojibwa during 1914 was limited in the main to translating the syllabic texts on mythology and ethnology obtained in the previous year and in the early part of 1914. Part of the time was also spent in obtaining additional grammatical data. The greater part of the year was taken up by Mr. Radin in working up for publication by the Survey a number of monographs based on material obtained for the Survey. These papers embrace: "Literary Aspects of North American Mythology," which is almost finished; a paper on "The Ethnology of the Ojibwa of southeastern Ontario," which is well under way; and a second set of "Ojibwa Myths," on which considerable work has been done. A special paper on "Ojibwa Religion" and a series of "Ojibwa Texts" have also been started.

A. A. Goldenweiser spent a period of about two and one-half months among the Iroquois Indians of New York State. Part of this time was taken up with the Seneca and Onondaga Reservations. The greater part of the season, however, was spent among the Tuscarora at Lewiston, New York. The list of Tuscarora names previously obtained was amplified, and a good start made on their translation. The total number of Tuscarora individual names now recorded approaches 500, about half of which are translated. Data on the social system of the Tuscarora were obtained, including a genealogy embracing with marriages some 800 individuals. The terms of relationship were recorded and the system, somewhat different from that of the five other League tribes, was carefully studied. Some interesting data were collected on clan origins. Miscellaneous data on medicines and magic were secured, and several historic traditions and myths were recorded in English.

Toward the last of May, E. W. Hawkes left for field work among the Eskimo of Labrador. While the northern coasts were blocked with ice, a thorough exploration of Hamilton inlet and Sandwich bay was undertaken to ascertain definitely the present southern limit of Eskimo culture, and considerable ethnological material was obtained. Later the east coast was carefully surveyed to Cape Chidley, and further ethnological specimens obtained; but particular attention was paid to archæological remains of the ancient Eskimo and Tornit cultures. On August 2, Mr. Hawkes joined the Carnegie Magnetic expedition from Washington, D.C., and was then able to extend operations to Hudson strait and bay. Both sides of the strait and bay were visited, including the little-known east coast of Hudson bay as far south as Cape Dufferin, Coats island, and southern Baffin island. Interesting specimens were obtained from this district and Chesterfield inlet. As a result, the Museum has a complete ethnological and archæological Labrador Eskimo collection, with interesting comparative specimens from neighbouring tribes.

W. D. Wallis spent nearly four months in southern Manitoba, studying the Dakota (Sioux) tribe. Two reservations were visited, that at Portage-la-Prairie, and that at Griswold. A number of specimens were collected for the Museum, principally of leather and bead work, and a number of photographs were secured. The Dakota were found to be a conservative people, rich in ethnological data and in material culture. Attention was given mainly to the dance and ceremonial organizations, and of several of these a long and fully representative account was obtained, though owing rather to lack of opportunity than of procurable data, no account was obtained of some five or six such associations. A fairly complete description of the Sun Dance and of the Medicine Society was procured. Several medicine bags were collected, and songs describing and uses pertaining to each were obtained. Incomplete notes were taken down on various phases of the social organization, such as birth and death rights, naming customs, war honours, and others. Many myths and stories were recorded in translation, including the complete cycle of Spider myths, and information on religious concepts and practices was procured as far as this was possible. Over fifty songs were recorded and taken in text.

Since last reported on, three letters have been received from D. Jenness, ethnologist of the Canadian Arctic expedition. These are dated February 27, 1914, from Point Barrow, Alaska, May 30, 1914, from Barter island, and July 30, 1914, from the *Mary Sachs*. A report of progress, covering the period from September, 1913, to July, 1914, has also been received. Anthropological work was undertaken at this time under exceptionally difficult circumstances, one of the most serious handicaps being the loss of anthropometric instruments and of many anthropological books on the *Karluk*. However, encouraging progress was made on several phases of ethnological work at Harrison bay, Collinson point, and at the Alaska-Canada boundary line. Considerable attention was paid to Eskimo linguistics. A close study was also made both among the Barrow natives and among the Eskimo to the eastward of the game of cat's cradle, more than one hundred different figures being recorded, many of these being accompanied by chants. Some variants from Eskimo of different regions were also obtained, for by happy coincidence there was a woman at Collinson point from Cape Prince of Wales, and a number of Siberian natives from the steam whaler *Belvedere*, jammed in the ice off Manning point. It is hoped that these and further researches in the same direction will help to throw some light on the problem of the diffusion of the different branches of the Eskimo race. A set of ethnological notes sent to the Survey by Mr. Jenness have been received by the Division. Probably the most important anthropological work done by Mr. Jenness during the summer was the careful archæological study of the remains on Barter island. There were formerly two settlements on Barter island, one on the western sandspit, the other and larger on the eastern. Of the sixteen ruins on the former, five were excavated independently by an Eskimo who had in previous years dug sporadically at various places along the coast and sold his specimens to stray white collectors; on this occasion Mr. Jenness purchased almost all the objects that had been unearthed. The remaining eleven sites were excavated by Mr. Jenness, one only being left unfinished because the floor, though it had lain exposed for a week, still remained frozen. On the eastern sandspit thirty-seven ruins were completely excavated. In ten others the floor was reached, while about fifteen remained untouched. Further, a large settlement was investigated on a sandspit some 3 miles west of Barter island. Here many of the ruins had been ransacked by the Eskimo themselves, but Mr. Jenness excavated about twelve either wholly or in part in order to discover their relation to the ruins on Barter island. Detailed notes were made of the principal objects discovered in each ruin, with rough plans of the settlements themselves and of the individual ruins. An attempt was made to keep the remains separate with a view to ascertaining whether the sandspits had been occupied at different periods or not. The large archæological collection thus obtained by Mr. Jenness was shipped by him to the Survey and has been received by the Division.

The disastrous outcome of that part of the Canadian Arctic expedition which drifted on the *Karluk* involved the death in the earlier part of the year of Henri Beuchat, one of the two anthropologists of the expedition. In M. Beuchat, the scientific world has lost one of its foremost Americanists.

Publications.

Manuscripts Received.

A number of manuscripts of ethnological interest were obtained during the year as gifts. These embrace:

From F. G. Speck, Philadelphia, Pa.—

"The Hunting Territories and Mythology of the Timagami Indians," manuscript of 83 pages with accompanying map (MS. 44).

"Family Hunting Territories of the Dumoine and Kippéwa Bands of Algonquins," manuscript of 2 pages with accompanying map (MS. 48).

Painted basket designs to accompany paper on "The Decorative Art of the Mohegan, Scatticook, and Niantic Indians of Connecticut," presented in 1913.

"Micmac Family Hunting Territories in Cape Breton," manuscript of 5 pages with accompanying map (MS. 56).

"Family Hunting Territories of the Micmac-Montagnais of Newfoundland," manuscript of 11 pages with accompanying map (MS. 50).

From P. Radin.—

"The Social Organization of the Winnebago Indians—An Interpretation," manuscript of 75 pages (MS. 57).

From Mr. Skavlem, Janesville, Ill.—

Copy of Ojibwa Medewin record from Nett Lake, Minnesota, in his possession (MS. 47).

Several manuscripts have been turned in to the Division as a result of research work undertaken under the auspices of the Geological Survey. They embrace:

By F. W. Waugh.—

"Iroquois Foods and Food Preparation," manuscript of 177 pages (MS. 49).

By C. M. Barbeau.—

"Huron and Wyandot Mythology," manuscript of 450 pages (MS. 62).

By F. H. S. Knowles.—

"The Glenoid Fossa in the Skull of the Eskimo," manuscript of 18 pages (MS. 61).

By P. Radin.—

"The Ethnology of the Ojibwa of Southeastern Ontario," manuscript of 69 pages (MS. 42).

"Ojibwa Ethnological Notes Obtained at Sarnia, Ontario," manuscript of 39 pages (MS. 63).

By W. H. Mechling.—

"Malecite Myths," manuscript of 29 pages supplementary to MS. 33 received in 1913 (MS. 43).

By C. McMillan.—

"The Micmacs, Their Life and Legends," manuscript of 400 pages (MS. 51).

By E. W. Hawkes.—

Set of Labrador Eskimo clothing patterns with accompanying manuscript of 7 pages (MS. 54).

By W. D. Wallis.—

Manuscript of 6 pages describing Sioux tipi sent to the Museum.

By D. Jenness.—
"Eskimo Ethnological Notes," manuscript of 262 pages (MS. 58).

By J. A. Mason.—
"Notes on Northeastern Athabaskan Culture," manuscript of 50 pages (MS. 45).

Ethnological Manuscripts Purchased in the Course of the Year.

From F. G. Speck, Philadelphia.—
"Gluskabe, the Deceiver—Penobscot Transformer Texts," manuscript of 80 pages (MS. 55).

From A. B. Reagan, Nett Lake, Minn.—
Manuscripts in explanation of 6 Medicine Lodge bark records (MSS. 52 and 52*a*-52*e*).

From Frank Williams, Alberni, B.C.—
"Raven and Snipe," Nootka text, manuscript of 3 pages (MS. 53).

From Alex. Thomas, Alberni, B.C.—
Names of Nootka months, manuscript of 1 page (MS. 50).
"Speech of Thanks to Kyuquot Indians," Nootka text, manuscript of 5 pages (MS. 50*a*).
"Adventures of Sixnate," Nootka text, manuscript of 10 pages (MS. 50*b*).
"Capture of Whale during Famine, and Whaling Customs," Nootka text, manuscript of 21 pages (MS. 50*c*).

From Alex. Thomas, Alberni, B.C.—
Invitation speech, Nootka text, manuscript of 12 pages (MS 50*d*).
"Marriage of Mink," Nootka text, manuscript of 8 pages (MS 50*e*).
"Fight about Hunting Grounds between Chiefs of Lice People and Wolf People," Nootka text, manuscript of 7 pages (MS. 50*f*).
Speech given by Tlutasi's, Nootka text, manuscript of 3 pages (MS. 50*g*).
"Myth of Stealing of Children," Nootka text, manuscript of 22 pages (MS. 50*h*).
"Ucluelet Bands and Seating," manuscript of 10 pages (MS. 50*k*).
"Ucluelet War Story," Nootka text, manuscript of 148 pages (MS. 50*l*).
"War Waged by Ucluelets and Clayoquots against Hach'a'ath," Nootka text, manuscript of 24 pages (MS. 50*m*).
"War between Ucluelets and Uchucklesits" Nootka text, manuscript of 50 pages (MS. 50*n*).
Invitation speech, Nootka text, manuscript of 2 pages (MS. 50*o*).

From Alex. Thomas and Douglas Thomas, Alberni, B.C.—
16 pages of Nootka Indian face paintings with 68 accompanying pages in explanation of these (MS. 50*i*).

Manuscripts Submitted for Publication.

In the course of the year the following ethnological papers have been submitted to the Deputy Minister of Mines for publication by the Division:

F. G. Speck.—
"Family Hunting Territories and Social Life of Various Algonkian Bands of the Ottawa Valley."
"Myths and Folk-lore of the Timiskaming Algonquin and Timagami Ojibwa" (including MS. 38 received as gift from Neil Fergusson, L. Timigami, in 1913).
"Some Naskapi Myths from Little Whale River."
The first two of these papers were intended to be published in the form of Museum Memoirs, the third as a Museum Bulletin.

Ethnological Publications.

The following Memoir was published in 1913:

E. W. Hawkes, "The Inviting-In Feast of the Alaskan Eskimo," (Memoir 45, Anthropological Series No. 3).

The following Memoirs were published in 1914:

F. G. Speck, "The Double Curve Motive in Northeastern Algonkian Art" (Memoir 42, Anthropological Series No. 1).

P. Radin, "Some Myths and Tales of the Ojibwa of Southeastern Ontario" (Memoir 48, Anthropological Series No. 2).

W. H. Mechling, "Malecite Tales" (Memoir 49, Anthropological Series No. 4).

The following Bulletins were published in the course of the year:

P. Radin, "Some Aspects of Puberty Fasting among the Ojibwa" (published in Museum Bulletin No. 2, Anthropological Series No. 2).

V. Stefansson, "Prehistoric and Present Commerce among the Arctic Coast Eskimo" (Museum Bulletin No. 6, Anthropological Series No. 3).

PART II.

ARCHÆOLOGY.

(*Harlan I. Smith.*)

Exhibits.

The tentative archæological exhibits, made up of representative collections from the entire national collections, have been increased and improved as a result of the field work of the year, especially by the finds in Nova Scotia, and the rare specimens from Manitoba. A handbook entitled "The Archæological Collection from the Southern Interior of British Columbia" has been published and placed with the collection, which is fairly large and representative. This handbook is intended to interpret the scientific publications on the subject and illustrates about half of the specimens exhibited. Lectures on the archæology of Canada have been given in Halifax, Truro, Kemptville, and Ottawa. Popular accounts on "The Archæology of Canada," "Archæological Value of Human Bones," and "Archæology of the Rocky Mountains Park" have been written. The latter was published by the Parks Branch of the Department of the Interior. The collections being practically useless should our single catalogue be destroyed by fire or otherwise lost, typewriting the catalogues with two carbon copies has been begun, so that one copy may be deposited elsewhere to safeguard the records.

Research.

Research work has proceeded, additions having been made to the card catalogue of archæological literature and especially to the files of data, some of which are now approaching such volume as to promise sufficient material for the basis of publications. All the material collected on the Iroquoian village site at Roebuck, Ontario, in 1912, 4,411 entries, some of them covering over 24 specimens; all the material collected in the field work in Manitoba and the Maritime Provinces during 1913; and part of the collection made by the field parties in 1914, have been cleaned and catalogued. All the material collected since 1911 will probably be catalogued before another field season begins and part of the old material will also receive attention.

Circular letters have been sent to over 140 collectors of Canadian archæological material requesting their co-operation in securing data and gifts of specimens.

Field Work.

Field work was carried on in northern Nova Scotia, eastern Ontario, southwestern Manitoba, and on the Arctic coast.

The work in northern Nova Scotia, under the archæologist, was confined to the shell-heaps of Merigomish harbour, and resulted in obtaining perhaps the most complete and detailed data so far secured regarding the archæology of Nova Scotia, as well as one of the three largest collections of Nova Scotian specimens. No burials were discovered. These shell-heaps are usually located on the most sheltered places, generally on southern shores; and on islands rather than the mainland, although there are some small heaps on the latter. The sites are above high tide, but usually on low places sheltered from the wind by bluffs. They are probably the remains of Micmac villages. Chipped points of stone for arrows, celts of stone, pottery and sharpened bones, were very numerous. Little knives or chisels made from beaver teeth, harpoon points made of bone, and other artifacts were frequently found. Gouges were entirely absent, although common enough from Nova Scotia, and represented in some collections by about as many specimens as there are of celts. On the whole the quantity of specimens found in the shell-heaps was much less than would be found in some village sites in southern Ontario. The report on the culture is in process of preparation. Mr. Smith also examined a kitchen midden located below high tide mark at Chester Basin, N.S., and photographed specimens in the Provincial Museum and Dalhousie University, both in Halifax, N.S.

The work in eastern Ontario was carried on by Mr. W. J. Wintemberg, and was confined to reconnaissance in the St. Lawrence valley south of Ottawa, particularly between Summerstown, Glengarry county, and Picton, Prince Edward county. The object of the reconnaissance was to locate a site of sufficient size and importance to produce material for determining the culture of the site and for a monograph of a different culture from that of the Iroquoian village near Roebuck in this same area, which was excavated by Mr. Wintemberg in 1912. This reconnaissance resulted in the discovery of a number of sites and several mounds and graves, all apparently of Algonkian origin, but none of them sufficiently extensive to cause the reconnaissance to give way to intensive work. Some rich sites of the same culture as that found at Roebuck were also found, so that the extent of this culture, or its "horizon," is gradually being worked out as a by-product of other work. There are several cultures represented by specimens found in this general vicinity. It is the purpose of archæological work to monograph each of these cultures, and, so far as possible, to make exhibits illustrating the monographs for museums. During the reconnaissance Mr. Wintemberg secured from his own work and by gift numerous specimens for the national collection.

The archæological exploration in southwestern Manitoba was carried on intensively by Mr. W. B. Nickerson in continuation of his reconnaissance of 1912 and intensive work of 1913, and was directed towards the exploration of mounds and village sites. The results were much more gratifying than in previous years, consisting of information, photographic films, archæological specimens, and a number of human skeletons, sufficient to give some idea of the physical anthropology of the people, and especially desirable from a region so poorly represented in somatological collections. The archæological specimens include, besides what is ordinarily found in the region, rare objects made of copper, marine shells, and stone. There is also a tibia in which is embedded part of a chipped stone arrow that has become partly covered by a growth of bone. Mr. Nickerson's annual manuscript report summarizes existing data on the archæology of the region, but will not be published until a culture may be characterized in some detail. He believes the culture to be very old—oldest in the Pembina valley, and most recent in the Souris valley, where pottery is more plentiful.

The Eskimo archæological work at Barter island, undertaken by Mr. D. Jenness, is reported on in Part I.

Accessions.

The chief additions to the archæological collections are as follows:

Collected by Officers of the Department.

Accessions 124, 126, 127, 129. Archæological specimens, human skeletons, and photographic films, from Sourisford and Snowflake, Manitoba. Collected by Mr. W. B. Nickerson on Geological Survey expedition.

Accessions 125, 128. Archæological specimens and photographic negatives from Merigomish harbour, Nova Scotia. Collected by Mr. Harlan I. Smith on Geological Survey expedition.

Accession 141. Archæological specimens from near Point Barrow, Alaska. Collected by Mr. Charles D. Brower for Canadian Arctic expedition.

Shipment of 20 boxes and 1 parcel containing archæological specimens from Barter island. Collected by D. Jenness, of Canadian Arctic expedition.

Minor addition from expeditions are as follows:

Accessions 106, 108, 110, 112, 113, 115, 118, 120, 121, 131, 133-137, 139, 144 and 145. Archæological specimens from Iroquoian village site, Charlottenburg township, Ontario; from camp site on the east bank of a small creek on lot 34, concession I, Osnabruck township, Stormont county, Ontario; from east end of Tar island, Leeds county, Ontario; from the shore of the north side of Grenadier island, Leeds county, Ontario; from Pine point, east shore of Lower Beverly lake, on farm of Mr. William Halliday, lot 25, concession X, Bastard township, Leeds county, Ontario, two soapstone beads, one pottery bead, one chipped stone point for a spear, pottery fragments, fragments of pottery pipes, and bone probably for use in a game, from Roebuck site, Ontario; unfinished chipped implement, from lot 27, South range, Howe island, Frontenac county, Ontario; pottery fragments and chipped stone implements, from lot 29, concession VI, Camden township, Lennox and Addington counties, Ontario; pottery fragments, chert chippings, and chipped chert scraper, from south half of lot 43, concession III, Camden township, Lennox and Addington counties, Ontario; surface finds on north bank of Trent river, lots 12 and 13, concession VIII, Sidney township, Hastings county, Ontario; pottery fragments, chippings, bone beads, unfinished stone adze, from Masson farm, lot 31 or 32, concession VI, Sidney township, Hastings county, Ontario; pottery fragments, chert and slate chippings, chipped stone point for an arrow, and broken and unfinished stone adzes, from Bradshaw farm, lot 15, concession VIII, Sidney township, Hastings county, Ontario; unfinished stone adze and chipped stone point for an arrow, from lot 7, concession I, Leeds township, Leeds county, Ontario; pottery fragments, chert scraper, and chert chippings from Mr. John Brown's farm, lot 1, Lakeside, North Marysburg township, Prince Edward county, Ontario; pottery fragments, chipped stone, and whetstone, from the Yarrow farm, lots 16 and 17, concession II, M. T., Hallowell township, Prince Edward county, Ontario; shell pendant, shell beads, and burnt human bone, found with a skeleton on Mr. James Bedborough's farm, lot 23, concession III, M. T., Hallowell township, Prince Edward county, Ontario; chipped stone point for a knife, from lot 15, concession IV, Seymour township, Northumberland county, Ontario; and photographic films exposed in Ontario. All collected by Mr. W. J. Wintemberg on Geological Survey expedition.

Accession 143. Archæological specimens from kitchen midden at head of Chester basin, fragment of pottery from pit near Chester Basin, Nova Scotia, and photographic films and plates. Collected by Mr. Harlan I. Smith on Geological Survey expedition.

Accession 148. Archæological specimens from Hudson bay and east coast of Labrador. Collected by Mr. E. W. Hawkes on Geological Survey ethnological expedition.

Other accessions include those sent in by officers of other divisions of the Geological Survey, as follows:

Accession 146. Chipped point and grooved adze, from Kluane lake, Yukon. Collected by Mr. D. D. Cairnes on Geological Survey expedition.

Accession 149. Archæological specimen from mainland opposite south end of Richmond island, at Nennorai, Mackenzie River delta. Collected by Mr. J. J. O'Neill on Canadian Arctic expedition.

Presented.

Gifts were received as follows:

Accession 100. Celt from Cape Breton, Nova Scotia. Presented by Mr. O. Thercoult.

Accession 101. One adze and two potsherds from Brantford, Ontario. Presented by Mr. G. N. Waugh, Brantford, Ontario.

Accession 103. Chipped pieces of chert, broken points chipped from stone, and core of chert from the surface of the banks of the creek at Johnston City, Texas. Presented by Mr. A. M. Scott, Ottawa.

Accession 104. Five specimens of chipped stone, from Nova Scotia. Presented by Mr. J. D. Cox, Upper Stewiacke, Nova Scotia.

Accession 105. Fragments of Siouan pottery from Nett Lake, Minnesota. Presented by Mr. A. B. Reagan Nett Lake, Minnesota.

Accession 107. Archæological specimens from St. John island, Charlotteburg township, Glengary county, Ontario. Presented by Messrs. Leander and Stanley Cameron, Summerstown post-office, Ontario.

Accession 109. One potsherd, four celts, and three chipped points, from shell-heap on Kerr point, on farm of Mr. Peter Millar, Merigomish harbour. Nova Scotia. Presented by Mr. Peter Millar, Merigomish. Nova Scotia.

Accession 111. Arrowhead from Escott, Leeds county, Ontario. Presented by Mr. A. Dickey, Rockport, Ontario.

Accession 114. Stem of a broken pottery pipe and three soapstone beads, from the Simpson farm, Augusta township, Grenville county, Ontario. Presented by Mr. Robert Simpson, Maynard, Ontario.

Accession 116. Broken unfinished stone pipe from Roebuck site, Ontario. Presented by Mr. Nathaniel White, Spencerville, Ontario.

Accession 117. Three fragments of pottery, from Edwardsburg township, Grenville county, Ontario. Presented by Mr. Rufus Froom, Cardinal. Ontario.

Accession 119. Pendant and scraper, from Alexander point, lot 10, concession VII, Wolfe Island, Frontenac county, Ontario. Presented by Mr. D. H. Pike, Wolfe Island, Ontario.

Accession 122. Stone knife from near Iroquois, Dundas county, Ontario. Presented by Mr. W. J. Wintemberg, Geological Survey.

Accession 123. One stone celt and two chipped stone points for arrows, from on or near Six Nations Reserve, Brant county, Ontario. Presented by Mr. Simeon Gibson, Middleport, Ontario.

Accession 130. Point for spear or knife, made of copper, from high land, southeast of Fairy lake, Wright county, Quebec. Presented by Miss Cynthia Garry, Ottawa.

Accession 132. Archaeological specimens from Beothuk Indian sites, Newfoundland. Presented by Professor F. G. Speck, University of Pennsylvania, Philadelphia, Pa.

Accession 138. Copper bead and portion of copper spike, found with a skeleton on Mr. James Bedborough's farm, lot 23, concession III, M. T., Hallowell township, Prince Edward county, Ontario. Presented by Mr. George Leslie, Picton, Ontario.

Accession 140. Shell beads found with skeleton on Mr. Bradshaw's farm, lot 15, concession VIII, Sidney township, Hastings county, Ontario. Collected by Mr. Geo. Bailey, and presented by Dr. J. Potts, Stirling, Ontario.

Accession 142. Three points chipped from stone, from the Great Slave Lake region. Presented by Mr. C. D. LaNauze, Corp. R.N.W.M. Police, Fort McMurray, Alberta.

A collection of duplicate specimens from the southern interior of British Columbia was given to the Rocky Mountains Museum maintained by the Dominion Parks Branch of the Department of the Interior at Banff, Alberta.

PART III.

PHYSICAL ANTHROPOLOGY.

(F. H. S. Knowles.)

Museum.

Exhibits.

During October three head and shoulder casts and two face masks of Iroquois Indians, taken by F. W. Waugh during field work at Six Nations Reserve in Brant county, Ontario, were prepared for exhibition in the Anthropological Hall. The three casts, and a plaster bust of an Iroquois girl made by Mr. A. E. Rost, Oxford, England, on the basis of photographs and measurements taken by Mr. Knowles in the summer of 1912, are now in place on the Iroquois cases. A bust of Chief Tedlenitsa of the Thompson River Indians (see below) has also been placed on exhibition.

Accessions.

Museum material coming under the head of physical anthropology was received in the course of the year as gifts, as a result of field work undertaken by the Division, and by purchase.

The gifts embrace:

From H. M. Nelson, Ottawa.—
Parts of skeleton from lighthouse site on island opposite Aylmer, Que. Collected in 1900.

From Mrs. P. Lesueur, Ottawa.—
Skeleton from lake in northern Florida. Collected by Mrs. R. W. Baxter.

From Robert Simpson, Maynard, Ontario.—
Skull from Iroquoian village site on James Simpson's farm near Maynard, lot 2, concession III, Augusta township, Grenville county, Ontario.

The material obtained in the course of regular field work for the Survey is as follows:

By W. B. Nickerson.—
Skeletal remains from various mounds in Manitoba.

By C. D. Brower, Point Barrow, Alaska, for Canadian Arctic expedition.—
Skeletal remains from northern Alaska.

By E. W. Hawkes.—
Eskimo skull from Eskimo point, west coast of Hudson bay.
Eskimo skull from Big island, Baffin island.

By F. W. Waugh.—
Plaster face mask of Levi Joe, Iroquois from Six Nations Reserve, Ontario.
Face mask of Hardy Gibson, Cayuga Chief at Six Nations Reserve, Ontario.
Head and shoulder cast of Simeon Gibson, Six Nations Reserve, Ontario.
Head and shoulder cast of David Jack, Iroquois of Six Nations Reserve, Ontario.
Head and shoulder cast of John Jamieson, Iroquois of Six Nations Reserve, Ontario.

The five casts last enumerated were taken by Mr. Waugh during field work in the summer of 1914, on the Iroquois of Six Nations Reserve, Ontario. The casting and preparation for exhibition were done in the Museum by Mr. Waugh and Mr. Knowles. The face mask of Chief John Tedlenitsa, a Thompson River Indian taken by H. I. Smith in 1913, has been made into a bust by Mr. Waugh.

The material purchased otherwise than in course of field work embraces:

From Alfred Tremblay, Giffard, Que.
Skull and femur of Peetara Eskimo, Ponds inlet.

From Thomas Deasy, Massett.—
Cranium found on roadside at Massett, B.C.

From A. E. Rost, Oxford, England.—
Plaster bust of Iroquois girl of Six Nations Reserve, Ontario (see above).

Photographic Work.

A series of 45 negatives of interest for the study of physical anthropology was made from a number of illustrations in various works dealing with the subject of early man. These served as a basis for a set of lantern slides to be utilized for lecture purposes.

Research.

During August and September an examination was made of the material collected by the archæological section from the Roebuck site in Ontario. The various skeletons were catalogued and numbered and the skulls and other bones restored and repaired wherever it was possible to do so. All other skeletal material in the Division was similarly inspected, repaired, and catalogued to date.

Next, a careful examination was made of the skeletal material from an ossuary on Dee's farm outside Tuscarora, in Brant county, Ontario, collected by Mr. Knowles in the summer of 1911. From the skulls and long bones a number of notes and measurements were taken and various tables drawn up to illustrate the distribution of the measurements and indices. These will serve as preliminary data for what it is hoped may eventually be an extended investigation into the physical characteristics of the ancient inhabitants of eastern Canada.

In October there was received a large accession of skeletal material from the mounds of Sourisford and Snowflake in Manitoba. This had been collected for the survey by Mr. W. B. Nickerson during the summer; it was inspected, repaired, and catalogued.

From November 17 to December 11 research work was undertaken in the museums of Toronto. In the Provincial Museum there is a remarkably fine collection of skulls from Ontario, while in the Royal Ontario Museum the cranial collection of the late Sir Daniel Wilson is housed. In the same museum there is also a very fine series of skeleton remains collected by Professor Montgomery from mounds in Ontario and Manitoba. Thanks to the courtesy of Dr. Orr and Mr. Currelly, Mr. Knowles was enabled to obtain a detailed series of notes and measurements from over 200 skulls and a small number of long bones. The majority of these were from ossuaries, so that the material obtained should be of particular value for an investigation into the physical characteristics of the ancient Hurons. The remainder will be of use as preliminary data for an investigation into the physical characteristics of the Algonkian tribes.

GEOGRAPHICAL AND DRAUGHTING DIVISION.

(C.-Omer Senécal.)

During the past year, three members of the staff were transferred to other divisions of the Geological Survey, the total remaining force, at present, comprising the Geographer and Chief Draughtsman, his assistant, eight map compilers and draughtsmen, and one clerk. The appointment of a keeper of records is under consideration by the Civil Service Commission. As soon as a suitable person is selected, work on systematic classification and cataloguing of map records, correspondence, etc., will be undertaken.

Attention was, as in the past, given by the chief of the division to the duties of the Geographic Board of Canada, of which he is a committee member.

During the year, new editions of a large number of maps were ordered to be reprinted, including special editions for the Water Powers and Dominion Parks Branches of the Department of the Interior, for the Mines Branch of the Department of Mines, and for the Geographic Board of Canada. Reprints of the complete set of Geological Congress maps (138 maps) were also ordered for the French edition of the Excursion Guide books. Most of these Congress maps have now gone through press.

There are at present, under construction in the office, several important maps which have required the continuous attention of four compilers for the whole year. These maps include, the Sudbury district, Ontario, the Nottaway district, Quebec, the Gatineau district, Quebec, and the serial sheets of the Province of Nova Scotia. The Sudbury and Gatineau maps are nearing completion and will be engraved during the coming year.

The maps listed below were, at the end of the calendar year, in the hands of the King's Printer:—

Maps in Hands of King's Printer, December 31, 1914.

Series A.	Publication Number.	Title.	Sent to King's Printer.
33	1179	Nanaimo sheet, B.C., topography	July 11, 1912.
41	1191	Duncan sheet, B.C., topography	" 11, 1912.
58	1226	Nelson and Churchill rivers, Manitoba and Saskatchewan.	April 14, 1913.
66	1245	Brechin sheet, Ontario, topography	" 18, 1914.
67	1246	Kirkfield sheet, Ontario, topography	" 18, 1914.
111	1329	Vananda, Texada island, B.C., topography	" 22, 1914.
20	1148	Victoria sheet, Vancouver island, B.C., topography (reprint	" 30, 1914.
21	1149	Saanich sheet, Vancouver island, B.C., topography (reprint	" 30, 1914.
70	1251	Victoria sheet, Vancouver island, B.C., geology	" 30, 1914.
72	1253	Saanich sheet, Vancouver island, B.C., geology	" 30, 1914.
71	1252	Victoria sheet, Vancouver island, B.C., surface geology	" 30, 1914.
73	1254	Saanich sheet, Vancouver island, B.C., surface geology	" 30, 1914.
109	1313	Prescott, Paxton, and Lake mines, Texada island, B.C., topography	May 7, 1914.
......	1400 to 1409	Ten key maps of Provinces and Territories for the catalogue of publications	Aug. 6, 1914.
....	963	Moose Mountain region, geology (reprint)	" 6, 1914.
....	1489	Diagram of Bonanza creek, Yukon	" 11, 1914.
....	1447	Diagram of Prairie hills and Dogtooth mountains	" 11, 1914.
....	1448	Diagram of Albert canyon	" 11, 1914.
....	1449	Diagram of Glacier	" 11, 1914.
....	1450	Geology of railway belt between Golden and Revelstoke	" 11, 1914.
....	1457	Structure section of Selkirk and Purcell mountains	" 11, 1914.
....	1458	Diagram of major subdivisions of Cordillera and approximate distribution of Shuswap terrane, B.C	" 11, 1914.
....	772	Klondike mining district, Yukon, geology (reprint)	Sept. 14, 1914.
....	885	Klondike and vicinity, Yukon (reprint)	" 14, 1914.
....	886	Klondike mining district, Yukon, auriferous gravels (reprint)	" 14, 1914.
....	990	Conrad and Whitehorse mining districts, Yukon (reprint)	Oct. 28, 1914.
139	1412	Coal-fields of British Columbia	Nov. 6, 1914.
....	1413 to 1435	23 diagrams of coal-fields of British Columbia	" 6, 1914.
144	1479	Hunting territories of Timagami, Timiskaming, Kipawa, and Dumoine Indian bands, Ontario and Quebec.	" 9, 1914.
....	1478	St. Lawrence submerged coastal plain, Quebec.	Dec. 29, 1914.

The following maps were drawn and engraved by the office copper engraver:—

Victoria and Saanich sheets, B.C. Engraving completed.

Upper White River district, Yukon, Topography. Engraving completed.

" " " Geology. Engraving completed.

Frank landslide, 1903, Alberta. In progress.

During the year, 125 sketch maps, diagrams, text figures, indexes, and other drawings were prepared to illustrate memoirs in course of publication for the different divisions of the Department.

A list of the map editions received from the King's Printer, during the calendar year, is appended herewith:—

List of Geological Survey Maps Published During the Year 1914.

Series A.	Publication number.	TITLE.	Remarks.
102	1302	Northern Canada.—Eskimo trade routes, Arctic coast. Scale, 250 miles to 1 inch..	Route map.
125	1372	Canada.—Coal areas. Scale, 250 miles to 1 inch	Economic geology.
—	—	" .—Physiographic provinces. Scale, 250 miles to 1 inch........	Printed for the Geographic Board of Canada.
74	—	" .—Geology of the Forty-ninth parallel. Scale, 0·9864 miles to 1 inch.......	Reprinted for Mines Branch.
113	1332	Yukon.—Canadian routes to White River district, Yukon, and to Chisana district, Alaska. Scale, 16 miles to 1 inch........	Route map.
43	1193	British Columbia.—Sooke sheet, Vancouver island. Scale, 1 : 125,000........	Topography.
92	1278	" " .—Coast and islands, Queen Charlotte sound to Burke channel. Scale, 4 miles to 1 inch........	Geology.
99	1298	" " .—Southern portion of Cranbrook map-area, Kootenay district. Scale, 4 miles to 1 inch	Areal geology.
—	1321	" " .—Texada island. Scale, 2 miles to 1 inch........	Areal geology.
—	—	" " .—Security ground, Texada island........	Geological sketch.
—	1346	" " .—Plan of levels, Marble Bay mine, Texada island. Scale, 120 feet to 1 inch........	Geology.
—	1347	" " .—Plan of levels, Little Billy mine, Texada island. Scale, 100 feet to 1 inch........	Geology.
—	1348	" " .—Plan of 360-foot level, Cornell mine, Texada island. Scale, 100 feet to 1 inch........	Geology.
—	1436	" " .—Kokshittle arm, and Easy creek, Kyuquot sound. Scale, about 2,000 feet to 1 inch	Geology.
—	1365	" " .—Plan of 530-foot level, Hidden Creek mine, Granby bay. Scale, 240 feet to 1 inch........	Geology.
—	1349	" " .—Rainy Hollow, Atlin mining district. Scale, 2 miles to 1 inch..	Geology.
—	—	" " .—Alpha and adjacent mining claims, Hidden creek, Observatory inlet. Scale, 400 feet to 1 inch........	Geology, reprint.
120	1351	" " .—Quadra island. Scale, 4 miles to 1 inch........	Economic geology.

97	1286	" " .—Franklin mining camp, Kootenay district. Scale, 1 : 24,000....	Geology.
133	1381	" " .—Mineral claims, Franklin mining camp, Kootenay district. Scale, 2,500 feet to 1 inch....	Geology.
—	1382	" " .—Block diagram of McKinley mine, Franklin mining camp, Kootenay district....	Geology.
—	—	" " .—Franklin intermontane trough, etc., Kootenay district. Scale, 4 miles to 1 inch....	Physiography.
136	1392	" " .—Hazelton-Aldermere, Cassiar and Coast districts. Scale, 4 miles to 1 inch....	Topography, advance edition.
130	1377	" " .—Crowsnest coal-fields, Kootenay district. Scale, 4 miles to 1 inch	Economic geology.
131	1378	" " .—Southern Vancouver island. Scale, 6 miles to 1 inch....	Geology.
129	1376	Alberta and British Columbia.—Coal-fields. Scale, 40 miles to 1 inch....	Economic geology.
114	1335	Alberta.—Sheep river. Scale, 1 mile to 1 inch....	Economic geology.
130	1377	" .—Blairmore-Frank coal-field. Scale, 4 miles to 1 inch....	Economic geology.
55	1221	Alberta, Saskatchewan, and Manitoba.—The provinces. Scale, 35 miles to 1 inch...	Geology.
119	1350	Saskatchewan.—Willowbunch coal area. Scale, 4 miles to 1 inch....	Economic geology.
—	966	" .—Coal areas, Moose Mountain region. Scale, 2 miles to 1 inch....	Economic geology, reprint.
123	1375	Manitoba and Saskatchewan.—Coal-fields. Scale, 40 miles to 1 inch....	Economic geology.
49	1199	Ontario.—Orillia sheet, Simcoe and Ontario counties. Scale, 1 : 62,500....	Topography.
98	1299	" .—Rainy lake, Rainy River district. Scale, 1 mile to 1 inch....	Geology.
116	1337	" .—Southwestern Ontario. Scale, 12 miles to 1 inch....	Geology.
—	1473	" .—Craig mine, Raglan township. Scale 800 feet to 1 inch....	Diagram.
124	1356	" .—Wanapitei, Sudbury district. Scale, 1 mile to 1 inch....	Geology.
—	802	Quebec.—Gaspe oil-fields. Scale, 2 miles to 1 inch....	Reprint.
93	1280	" .—Kewagama, Abitibi, and Pontiac counties. Scale, 4 miles to 1 inch....	Geology.
101	1301	" .—St. Hilaire and Rougemont mountains, Rouville and St. Hyacinthe counties. Scale, ½ mile to 1 inch....	Geology.
134	1390	" .—Part of province. Scale, 35 miles to 1 inch....	Key map.
26	1162	New Brunswick.—Bathurst and vicinity, Gloucester county. Scale, 1 : 62,500....	Topography.
27	1163	" .— " " " " "....	Geology.
35	1181	" .—Albert and Westmorland counties. Scale, 1 : 62,500....	Economic geology.
61	1232	" .—Tobique, Victoria county. Scale, 1 : 125,000....	Topography.
39	1185	Nova Scotia.—General map of the province. Scale, 8 miles to 1 inch....	Geology.
121	1353	" .—Franey mine and vicinity, Victoria county. Scale, 1,500 feet to 1 inch.	Geology.
—	1352	" .—Underground workings, Franey mine, Victoria county....	Geology.

List of Geological Survey Maps Published During the Calendar Year 1914.—*Continued.*

Series A.	Publication number.	TITLE.	Remarks.
—	—	Malay archipelago.—Central portion of Timor island. Scale, 12 miles to 1 inch.....	Geology ; printed for proceedings of Twelfth International Geological Congress.
—	—	" " .—Diagrammatic sections across Timor island	Geology ; printed for proceedings of Twelfth International Geological Congress.
		Also reprints of Geological Congress Guide book maps, see list in Summary Report for 1913, and eight guide-book maps for the Dominion Parks and Water Power Branches of the Department of the Interior.	

LIBRARY.

(M. Calhoun, Acting Librarian.)

During the calendar year, 1,303 volumes and pamphlets were received as gifts or exchanges, including maps, reports, and publications of foreign Geological Surveys, together with memoirs, transactions, and proceedings of the scientific societies of Canada and other countries.

388 volumes were bound during the year.

149 periodicals were subscribed for.

826 volumes were added by purchase, costing $3,397.32.

Up to the present year, the libraray had no facilities for filing and storing the numerous maps in its possession. It is a pleasure to state that horizontal steel map cases have now been installed, and all maps will be arranged, and made available for use by the staff of the Survey, in the near future. A system of map classification is being worked out by the library committee.

In addition to the current cataloguing, the re-cataloguing of the old volumes in the library was continued, and the work on the geographical and anthropological sections has been completed.

Owing to the war, all German, Austrian, and Belgian publications have ceased coming to the library.

PUBLICATIONS.

(M. Sauvalle.)

The following reports have been published since January 1, 1914.—

1166. Memoir No. 19. Mother Lode and Sunset mines, Boundary district, B.C. By O. E. LeRoy. Published August 27, 1914.

1173. Memoir No. 20. Gold Fields of Nova Scotia. By W. Malcolm. Published February 21, 1914.

1188. Memoir No. 23. Geology of the coast and islands between the Strait of Georgia and Queen Charlotte sound, B.C. By J. A. Bancroft. Published January 16, 1914.

1190. Memoir No. 22. Preliminary report on the serpentine and associated rocks of southern Quebec. By J. A. Dresser. Published June 29, 1914.

1225. Memoir No. 30. The basins of Nelson and Churchill rivers. By W.. McInnes. Published February 4, 1914.

1242. Memoir No. 33. The geology of Gowganda mining division. By W. H. Collins. Published January 2, 1914.

1280. Memoir No. 39. Kewagama Lake map-area, Quebec. By M. E. Wilson. Published September 9, 1914.

1288. Memoir No. 40. The Archæan geology of Rainy lake re-studied. By A. C. Lawson. Published September 11, 1914.

1290. The Archæological collection from the southern interior of British Columbia. By H. I. Smith. Published April 29, 1914.

1293. Memoir No. 36. The geology of Victoria and Saanich map-areas, Vancouver island, B.C. By C. H. Clapp. Published April 17, 1914.

1305. Summary Report of Geological Survey, Department of Mines for the calendar year, 1912. Published June 17, 1914.

1309. Memoir No. 41. The "Fern Ledges": Carboniferous Flora of St. John, New Brunswick. By Marie C. Stopes. Published October 28, 1914.

1310. Memoir No. 42. The Double-curve motive in northeastern Algonkian art. By F. G. Speck. Published October 17, 1914.

1311. Memoir No. 43. St. Hilaire (Beloeil) and Rougemont mountains, Que. By J. J. O'Neill. Published June 1, 1914.

1315. Memoir No. 44. Clay and shale deposits of New Brunswick. By J. Keele. Published April 25, 1914.

1317. Memoir No. 45. The "Inviting-in" feast of the Alaskan Eskimo. By E. W. Hawkes. Published July 16, 1914.

1326. Memoir No. 48. Some myths and tales of the Ojibwa of southeastern Ontario. By Paul Radin. Published April 21, 1914.

1342. Museum Bulletin No. 2: Contains articles Nos. 13 to 18 of the Geological series and No. 2 of the Anthropological series of Museum Bulletins. Published July 30, 1914.

1344. Memoir No. 51. Geology of the Nanaimo map-area. By C. H. Clapp. Published October 27, 1914.

1357. Memoir No. 52. Geological notes to accompany map of Sheep River gas and oil fields, Alberta. By D. B. Dowling. Published June 1, 1914.

1363. Memoir No. 53. Coal fields of Manitoba, Saskatchewan, Alberta, and eastern British Columbia. By D. B. Dowling. Published December 7, 1914.

1366. Memoir No. 54. Annotated list of flowering plants and ferns of Point Pelee, Ont., and neighbouring districts. By C. K. Dodge. Published October 30, 1914.

1368. Notes on Radium-bearing minerals. By W. Malcolm. Published July 10, 1914.

1370. Memoir No. 55. Geology of Field map-area, British Columbia and Alberta. Published December 28, 1914.

1410. Memoir No. 61. Moose Mountain district, southern Alberta. By D. D. Cairnes. Published October 27, 1914.

1441. Museum Bulletin No. 3. The Anticosti Island faunas. By W. H. Twenhofel. Published November 17, 1914.

1459. Museum Bulletin No. 4. The Crowsnest Volcanics. By J. D. Mackenzie. Published November 24, 1914.

1467. Museum Bulletin No. 5. A Beatricea-like organism from the middle Ordovician. By P. E. Raymond. Published December 4, 1914.

1482. Museum Bulletin No. 7. A new species of Dendragapus (Dendragapus obscurus Flemingi) from southern Yukon Territory. By P. A. Taverner. Published December 19, 1914.

1483. Museum Bulletin No. 8. The Huronian formations of Timiskaming region, Canada By W. H. Collins. Published December 28, 1914.

FRENCH TRANSLATIONS.

(M. Sauvalle.)

1008. Lac Seul and Cat Lake report, by Dr. A. W. G. Wilson.

1080. Winisk and Upper Attawapiskat rivers, by W. McInnes. Published in 1914.

1065. Report on east side of Lake Timiskaming, by Morley E. Wilson. Published in 1914.

1092. Memoir No. 1: Geology of Nipigon basin, by A. W. G. Wilson. Published August, 1914.

1098. Reconnaissance across the MacKenzie mountains on the Pelly, Ross, and Gravel rivers, Yukon and North West Territories, by J. Keele. Published July, 1914.

1111. Memoir No. 4: Report on reconnaissance along National Transcontinental railway in western Quebec, by W. J. Wilson. Published June, 1914.

1161. Memoir No. 17-E: Geology and economic resources of Larder lake, Ontario, by Morley E. Wilson. Published in 1914.

1169. Report on explorations in the northeastern portion of the district of Saskatchewan and adjoining portions of the district of Keewatin, by J. B. Tyrrell; and report on geological explorations in Athabaska, Saskatchewan, and Keewatin districts, by D. B. Dowling. Published January, 1914.

1171. Memoir No. 18-E: Bathurst district, N.B., by G. A. Young. Published August 6, 1914.

1205. Memoir No. 24: Preliminary report on clay and shale deposits in western provinces, 1911, by H. Ries and Jos. Keele. Published in 1914.

1218. Summary Report of the Geological Survey for the calendar year 1911. Published in 1914.

1243. Memoir No. 33: Gowganda mining division, by W. H. Collins. Published October, 1914.

1328. Report on Graham island, B.C., by R. W. Ells. Published July, 1914.

1329. Report on Ekwan river, Sutton lakes, and west coast of James bay, by D. B. Dowling. Published May, 1914.

1330. Report on Klondike gold fields, by R. G. McConnell. Published December 9, 1914.

1331. Memoir No. 21: Geology and ore deposits of Phoenix Boundary district, B.C., by O. E. LeRoy. Published October 27, 1914.

1361. Memoir No. 35: Report on National Transcontinental railway in southern Quebec, by J. A. Dresser. Published August, 1914.

1362. Report on Moose Mountain area of the disturbed belt, southern Alberta, by D. D. Cairnes. Published August, 1914.

1380. Catalogue of French publications of the Department of Mines: Geological Survey and Mines Branch. Published July 1, 1914.

1393. Report on Telkwa river and vicinity, B.C., by W. W. Leach. Published September 29, 1914.

ACCOUNTANT'S STATEMENT.

(John Marshall.)

The funds available for the work and the expenditure of the Geological Survey for the fiscal year ending March 31, 1914, were:—

Details.	Grant.	Expenditure.
	$ cts.	$ cts.
Amounts voted by Parliament	522,230.66	
Civil list salaries		155,381.99
Explorations in British Columbia and Yukon		28,335.70
Topographical surveys in British Columbia		27,274.03
Explorations in North West Territories		9,691.03
Explorations in Ontario		9,531.98
Explorations in Quebec		6,576.35
Topographical surveys in Quebec		4,820.18
Explorations in New Brunswick		5,557.21
Explorations in Nova Scotia		6,110.77
Topographical surveys in Nova Scotia		2,328.89
Explorations in general		7,728.09
Palæontological investigations		6,656.86
International Geological Congress		9,961.77
Ethnological investigations		7,314.66
Arctic expedition		6,671.25
Archæological investigations		1,459.66
Investigation of road metals		409.89
Publication of reports		60,111.03
Publication of maps		14,876.97
Printing and stationery		17,025.87
Specimens for museum		13,872.65
Instruments and repairs		9,121.32
Miscellaneous		8,230 38
Wages, outside service		7,693 38
Library		6,251.10
Civil government contingencies		3,620.80
Photographic supplies		1,577.35
Advertising		1,350 30
Travelling expenses		792.78
Compensation to John F. Lyons		400.00
Advances to be accounted for in 1914-15		26.74
Balance unexpended and lapsed		81,469.68
	522,230.66	522,230.66

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Since 1910, reports issued by the Geological Survey have been called memoirs and have been numbered Memoir 1, Memoir 2, etc. Owing to delays incidental to the publishing of reports and their accompanying maps, not all of the reports have been called memoirs, and the memoirs have not been issued in the order of their assigned numbers, and, therefore, the following list has been prepared to prevent any misconceptions arising on this account. The titles of all other important publications of the Geological Survey are incorporated in this list.

Memoirs and Reports Published During 1910.

REPORTS.

Report on a geological reconnaissance of the region traversed by the National Transcontinental railway between Lake Nipigon and Clay lake, Ont.—by W. H. Collins. No. 1059.

Report on the geological position and characteristics of the oil-shale deposits of Canada—by R. W. Ells. No. 1107.

A reconnaissance across the Mackenzie mountains on the Pelly, Ross, and Gravel rivers, Yukon and North West Territories—by Joseph Keele, No. 1097.

Summary Report for the calendar year 1909. No. 1120.

MEMOIRS—GEOLOGICAL SERIES.

MEMOIR 1. *No. 1, Geological Series.* Geology of the Nipigon basin, Ontario—by Alfred W. G. Wilson.

MEMOIR 2. *No. 2, Geological Series.* Geology and ore deposits of Hedley mining district, British Columbia—by Charles Camsell.

MEMOIR 3. *No. 3, Geological Series.* Palæoniscid fishes from the Albert shales of New Brunswick—by Lawrence M. Lambe.

MEMOIR 5. *No. 4, Geological Series.* Preliminary memoir on the Lewes and Nordenskiöld Rivers coal district, Yukon Territory—by D. D. Cairnes.

MEMOIR 6. *No. 5, Geological Series.* Geology of the Haliburton and Bancroft areas, Province of Ontario—by Frank D. Adams and Alfred E. Barlow.

MEMOIR 7. *No. 6, Geological Series.* Geology of St. Bruno mountain, Province of Quebec—by John A. Dresser.

MEMOIRS—TOPOGRAPHICAL SERIES.

MEMOIR 11. *No. 1, Topographical Series.* Triangulation and spirit levelling of Vancouver island, B.C., 1909—by R. H. Chapman.

Memoirs and Reports Published During 1911.

REPORTS.

Report on a traverse through the southern part of the North West Territories, from Lac Seul to Cat lake, in 1902—by Alfred W. G. Wilson. No. 1006.

Report on a part of the North West Territories drained by the Winisk and Upper Attawapiskat rivers—by W. McInnes. No. 1080.

Report on the geology of an area adjoining the east side of Lake Timiskaming—by Morley E. Wilson. No. 1064.

Summary Report for the calendar year 1910. No. 1170.

MEMOIRS—GEOLOGICAL SERIES.

MEMOIR 4. *No. 7, Geological Series.* Geological reconnaissance along the line of the National Transcontinental railway in western Quebec—by W. J. Wilson

MEMOIR 8. *No. 8. Geological Series.* The Edmonton coal-field, Alberta—by D. B. Dowling.

MEMOIR 9. *No. 9, Geological Series.* Bighorn coal basin, Alberta—by G. S. Malloch.

MEMOIR 10. *No. 10, Geological Series.* An instrumental survey of the shore-lines of the extinct lakes Algonquin and Nipissing in southwestern Ontario—by J. W. Goldthwait.

MEMOIR 12. *No. 11, Geological Series.* Insects from the Tertiary lake deposits of the southern interior of British Columbia, collected by Mr. Lawrence M. Lambe, in 1906—by Anton Handlirsch.

MEMOIR 15. *No. 12, Geological Series.* On a Trenton Echinoderm fauna at Kirkfield, Ontario—by Frank Springer.

MEMOIR 16. *No. 13, Geological Series.* The clay and shale deposits of Nova Scotia and portions of New Brunswick—by Heinrich Ries, assisted by Joseph Keele.

MEMOIRS—BIOLOGICAL SERIES.

Memoir 14. *No. 1, Biological Series.* New species of shells collected by Mr. John Macoun at Barkley sound, Vancouver island, British Columbia—by William H. Dall and Paul Bartsch.

Memoirs and Reports Published During 1912.

REPORTS.

Summary Report for the calendar year 1911. No. 1218.

MEMOIRS—GEOLOGICAL SERIES.

Memoir 13. *No. 14, Geological Series.* Southern Vancouver island—by Charles H. Clapp.

Memoir 21. *No. 15, Geological Series.* The geology and ore deposits of Phoenix, Boundary district, British Columbia—by O. E. LeRoy.

Memoir 24. *No. 16, Geological Series.* Preliminary report on the clay and shale deposits of the western provinces—by Heinrich Ries and Joseph Keele.

Memoir 27. *No. 17, Geological Series.* Report of the Commission appointed to investigate Turtle mountain, Frank, Alberta, 1911.

Memoir 28. *No. 18, Geological Series.* The geology of Steeprock lake, Ontario—by Andrew C. Lawson. Notes on fossils from limestone of Steeprock lake, Ontario—by Charles D. Walcott.

Memoirs and Reports Published During 1913.

REPORTS, ETC.

Museum Bulletin No. 1: contains articles Nos. 1 to 12 of the Geological Series of Museum Bulletins, articles Nos. 1 to 3 of the Biological Series of Museum Bulletins, and article No. 1 of the Anthropological Series of Museum Bulletins.

Guide Book No. 1. Excursions in eastern Quebec and the Maritime Provinces, parts 1 and 2.

Guide Book No. 2. Excursions in the Eastern Townships of Quebec and the eastern part of Ontario.

Guide Book No. 3. Excursions in the neighbourhood of Montreal and Ottawa.

Guide Book No. 4. Excursions in southwestern Ontario.

Guide Book No. 5. Excursions in the western peninsula of Ontario and Manitoulin island.

Guide Book No. 8. Toronto to Victoria and return *via* Canadian Pacific and Canadian Northern railways: parts 1, 2, and 3.

Guide Book No. 9. Toronto to Victoria and return *via* Canadian Pacific, Grand Trunk Pacific, and National Transcontinental railways.

Guide Book No. 10. Excursions in Northern British Columbia and Yukon Territory and along the north Pacific coast.

MEMOIRS—GEOLOGICAL SERIES.

Memoir 17. *No. 28, Geological Series.* Geology and economic resources of the Larder Lake district, Ont., and adjoining portions of Pontiac county, Que.—by Morley E. Wilson.

Memoir 18. *No. 19, Geological Series.* Bathurst district, New Brunswick—by G. A. Young.

Memoir 26. *No. 34, Geological Series.* Geology and mineral deposits of the Tulameen district, B.C.—by C. Camsell.

Memoir 29. *No. 32, Geological Series.* Oil and gas prospects of the northwest provinces of Canada—by W. Malcolm.

Memoir 31. *No. 20, Geological Series.* Wheaton district, Yukon Territory—by D. D. Cairnes.

Memoir 33. *No. 30, Geological Series.* The geology of Gowganda Mining Division—by W. H. Collins.

Memoir 35. *No. 29, Geological Series.* Reconnaissance along the National Transcontinental railway in southern Quebec—by John A. Dresser.

Memoir 37. *No. 22, Geological Series.* Portions of Atlin district, B.C.—by D. D. Cairnes.

Memoir 38. *No. 31, Geological Series.* Geology of the North American Cordillera at the forty-ninth parallel, Parts I and II—by Reginald Aldworth Daly.

Memoirs and Reports Published During 1914.

REPORTS, ETC.

Summary Report for the calendar year 1912. No. 1305.

Museum Bulletins Nos. 2, 3, 4, 5, 7, and 8, contain articles Nos. 13 to 22 of the Geological Series of Museum Bulletins, article No. 2 of the Anthropological Series, and article No. 4 of the Biological Series of Museum Bulletins.

Prospector's Handbook No. 1: Notes on radium-bearing minerals—by Wyatt Malcolm.

MUSEUM GUIDE BOOKS.

The archæological collection from the southern interior of British Columbia—by Harlan I. Smith. No. 1290.

MEMOIRS—GEOLOGICAL SERIES.

Memoir 23. *No. 23, Geological* Series. Geology of the Coast and islands between the Strait of Georgia and Queen Charlotte sound, B.C.—by J. Austen Bancroft.

Memoir 25. *No. 21, Geological Series.* Report on the clay and shale deposits of the western provinces (Part II)—by Heinrich Ries and Joseph Keele.

Memoir 30. *No. 40, Geological Series.* The basins of Nelson and Churchill rivers—by William McInnes.

Memoir 20. *No. 41, Geological Series.* Gold fields of Nova Scotia—by W. Malcolm.

Memoir 36. *No. 33, Geological Series.* Geology of the Victoria and Saanich map-areas, Vancouver island, B.C.—by C. H. Clapp.

Memoir 52. *No. 42, Geological Series.* Geological notes to accompany map of Sheep River gas and oil field, Alberta—by D. B. Dowling.

Memoir 43. *No. 36, Geological Series.* St. Hilaire (Belœil) and Rougemont mountains, Quebec —by J. J. O'Neil.

Memoir 44. *No. 37, Geological Series.* Clay and shale deposits of New Brunswick—by J. Keele.

Memoir 22. *No. 27, Geological Series.* Preliminary report on the serpentines and associated rocks, in southern Quebec—by J. A. Dresser.

Memoir 32. *No. 25, Geological Series.* Portions of Portland Canal and Skeena mining divisions, Skeena district, B.C.—by R. G. McConnell.

Memoir 47. *No. 39, Geological Series.* Clay and shale deposits of the western provinces, Part III—by Heinrich Ries.

Memoir 40. *No. 24, Geological Series.* The Archæan geology of Rainy lake—by Andrew C. Lawson.

Memoir 19. *No. 26, Geological Series.* Geology of Mother Lode and Sunset mines, Boundary district, B.C.—by O. E. LeRoy.

Memoir 39. *No. 35, Geological Series.* Kewagama Lake map-area, Quebec—by M. E. Wilson.

Memoir 51. *No. 43, Geological Series.* Geology of the Nanaimo map-area—by C. H. Clapp.

Memoir 61. *No. 45, Geological Series.* Moose Mountain district, southern Alberta (second edition)—by D. D. Cairnes.

Memoir 41. *No. 38, Geological Series.* The "Fern Ledges" Carboniferous flora of St. John, New Brunswick—by Marie C. Stopes.

Memoir 53. *No. 44, Geological Series.* Coal fields of Manitoba, Saskatchewan, Alberta, and eastern British Columbia (revised edition)—by D. B. Dowling.

Memoir 55. *No. 46, Geological Series.* Geology of Field map-area, Alberta and British Columbia—by John A. Allan.

MEMOIRS—ANTHROPOLOGICAL SERIES.

Memoir 48. *No. 2, Anthropological Series.* Some myths and tales of the Ojibwa of southeastern Ontario—collected by Paul Radin.

Memoir 45. *No. 3, Anthropological Series.* The inviting-in feast of the Alaska Eskimo—by E. W. Hawkes.

Memoir 49. *No. 4, Anthropological Series.* Malecite tales—by W. H. Mechling.

Memoir 42. *No. 1, Anthropological Series.* The double-curve motive in northeastern Algonkian art—by Frank G. Speck.

MEMOIRS—BIOLOGICAL SERIES.

Memoir 51. *No. 2, Biological Series.* Annotated list of flowering plants and ferns of Point Pelee, Ont., and neighbouring districts—by C. K. Dodge.

Memoirs and Reports Published During 1915.

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Summary Report for the calendar year 1913, No. 1359.

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MEMOIR 66. *No. 54, Geological Series.* Clay and Shale deposits of the Western Provinces, Part V—by J. Keele.

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MEMOIR 63. *No. 6, Anthropological Series.* Noun reduplication in Comox, a Salish language of Vancouver island—by E. Sapir.

MEMOIR 46. *No. 7, Anthropological Series.* Classification of Iroquoian radicals with subjective pronominal prefixes—by C. M. Barbeau.

MEMOIR 70. *No. 8, Anthropological Series.* Family hunting territories and social life of the various Algonkian bands of the Ottawa valley—by F. G. Speck.

MEMOIR 71. *No. 9, Anthropological Series.* Myths and folk-lore of the Timiskaming Algonquin and Timagami Ojibwa—by F. G. Speck.

MEMOIR 69. *No. 57, Geological Series.* Coal fields of British Columbia—by D. B. Dowling.

MEMOIR 34. *No. 63, Geological Series.* The Devonian of southwestern Ontario—by C. R. Stauffer.

MEMOIR 73. *No. 58, Geological Series.* The Pleistocene and Recent deposits of the Island of Montreal—by J. Stansfield.

MEMOIR 68. *No. 59, Geological Series.* A geological reconnaissance between Golden and Kamloops, B.C., along the line of the Canadian Pacific railway—by R. A. Daly.

MEMOIR 72. *No. 60, Geological Series.* The Artesian Wells of Montreal—by C. L. Cumming.

MEMOIR 74. *No. 61, Geological Series.* A list of Canadian mineral occurrences—by R. A. A. Johnston.

MEMOIR 75. *No. 10, Anthropological Series.* Decorative art of Indian tribes of Connecticut—by Frank G. Speck.

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MUSEUM BULLETIN NO. 11. *No. 23, Geological Series.* Physiography of the Beaverdell map-area and the southern part of the Interior plateaus, B.C.—by Leopold Reinecke.

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MUSEUM BULLETIN NO. 14. *No. 25, Geological Series.* The occurrence of Glacial drift on the Magdalen islands—by J. W. Goldthwait.

Summary Report for the calendar year 1914.

SUMMARY REPORT

OF THE

MINES BRANCH

OF THE

DEPARTMENT OF MINES

FOR THE CALENDAR YEAR ENDING DECEMBER 31

1914

PRINTED BY ORDER OF PARLIAMENT.

OTTAWA
PRINTED BY J. de L. TACHÉ, PRINTER TO THE KING'S MOST
EXCELLENT MAJESTY.
1915

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To Field Marshal, His Royal Highness Prince Arthur William Patrick Albert, Duke of Connaught and of Strathearn, K.G., K.T., K.P., etc., etc., etc., Governor General and Commander in Chief of the Dominion of Canada.

MAY IT PLEASE YOUR ROYAL HIGHNESS:

The undersigned has the honour to lay before Your Royal Highness, in compliance with 6-7 Edward VII, chapter 29, section 18, the Summary Report of the work of the Mines Branch of the Department of Mines during the calendar year ending December 31, 1914.

LOUIS CODERRE,
Minister of Mines.

Hon. Louis Coderre,
Minister of Mines,
Ottawa.

Sir,—I have the honour to submit herewith, the Director's Summary Report of the work of the Mines Branch of the Department of Mines during the calendar year ending December 31, 1914.

I am, Sir, your obedient servant,

R. G. McCONNELL,
Deputy Minister.

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SUMMARY REPORT

OF THE

MINES BRANCH OF THE DEPARTMENT OF MINES

FOR THE CALENDAR YEAR ENDING DECEMBER 31, 1914

R. G. McConnell, Esq., B.A.,
Deputy Minister,
Department of Mines.

Sir,—I have the honour to submit, herewith, the Summary Report of the Mines Branch for the calendar year ending December 31, 1914.

CHANGES IN STAFF.

The following additions were made to the staff of the Mines Branch during 1914:—

Appointments—

David Westwood, appointed April 1, 1914, as draughtsman.
E. O'Leary, appointed June 1, 1914, as messenger.
Miss Della M. Stewart, M.A., appointed July 1, 1914, as technical typewriter.
H. C. Mabee, B.Sc., appointed August 19, 1914, as chemist, Ore Dressing and Metallurgical Division.
T. W. Hardy, B.Sc., appointed October 10, 1914, as assistant engineering chemist, Fuels and Fuel Testing Division.
H. H. Nicolls, M.Sc., appointed November 6, 1914, as assistant engineering chemist, Fuels and Fuel Testing Division.
E. S. Malloch, B.Sc., appointed December 10, 1914, as assistant technical engineer, Fuels and Fuel Testing Division.

Transferred—

L. J. MacMartin was transferred, January 1, 1914, from the messenger staff to a 3B clerkship in the Fuels and Fuel Testing Division.

Deceased—

C. T. Cartwright, B.Sc., assistant engineer, in the Division of Mineral Resources and Statistics, died October 26, 1914.

ORGANIZATION: CLASSIFIED LIST OF STAFF.

The following is a complete list of the technical officers and other employees at present on the staff of the Mines Branch:—

Administration Staff—

M. M. Farnham, B.A., secretary to the Mines Branch.
Miss J. Orme, private secretary.
W. Vincent, filing clerk.

Administration Staff—Continued.

G. Simpson, distribution clerk.
Miss I. McLeish, typewriter.
Miss W. Westman, typewriter.
Miss M. E. Young, typewriter.
Mrs. O. P. R. Ogilvie, librarian.
A. F. Purcell, messenger.
E. O'Leary, messenger.
John H. Fortune, caretaker.

Division of Mineral Resources and Statistics—

J. McLeish, B.A., chief of division.
J. Casey, clerk.
Mrs. W. Sparks, clerk
Miss G. C. MacGregor, B.A., clerk.
Miss B. Davidson, typewriter.

Division of Fuels and Fuel Testing—

B. F. Haanel, B.Sc., chief of division.
J. Blizard, B.Sc., technical engineer.
E. S. Malloch, B.Sc., assistant technical engineer.
A. Stansfield, M.Sc., engineering chemist.
F. E. Carter, B.Sc., Dr. Ing., assistant engineering chemist.
F. W. Hardy, B.Sc., assistant chemist.
H. H. Nicholls, M.Sc., assistant chemist.
A. von Anrep, peat expert.
L. J. MacMartin, clerk.

Ore Dressing and Metallurgical Division—

G. C. Mackenzie, B.Sc., chief of the division.
W. B. Timm, B.Sc., assistant engineer.
H. C. Mabee, B.Sc., chemist.

Division of Chemistry—

F. G. Wait, M.A., chemist, chief of the division.
M. F. Connor, B.A.Sc., assistant chemist.
H. A. Leverin, Ch.E., assistant chemist.
N. L. Turner, M.A., assistant chemist.

Division of Metalliferous Deposits—

A. W. G. Wilson, M.A., Ph.D., chief of the division
E. Lindeman, M.E., assistant engineer.
A. H. A. Robinson, B.A.Sc., assistant engineer.
Miss Della M. Stewart, M.A., technical typewriter.

Division of Non-metalliferous Deposits—

H. Fréchette, M.Sc., chief of division.
H. S. de Schmid, M.E., assistant engineer.
L. H. Cole, B.Sc., assistant engineer.
S. C. Ells, B.A., B.Sc., assistant engineer.

Division of Explosives—

J. G. S. Hudson.

NOTE.—This division will be fully organized when the Explosives Act has been put in force.

Draughting Division—

H. E. Baine, chief of the division.
L. H. S. Pereira, assistant draughtsman.
A. Pereira, draughtsman.
E. Juneau, draughtsman.
D. Westwood, draughtsman.
Wm. Campion, mechanical draughtsman.

OUTSIDE SERVICE.

Dominion of Canada Assay Office, Vancouver, B.C.—

G. Middleton, manager.
J. B. Farquhar, chief assayer.
A. Kaye, assistant assayer.
H. Freeman, assistant assayer.
D. Robinson, chief melter.
R. Allison, assistant melter.
G. N. Ford, computer and book-keeper.
T. B. Younger, clerk.
E. A. Pritchett, janitor.

INTRODUCTORY.

The work of the Mines Branch, especially that part concerning investigations dealing with subjects of great magnitude, necessitates the continuance, to a certain extent, of the programmes initiated in former years.

Consequently, the activities of this department during the year 1914 have been confined primarily to investigations in connexion with our metallic and non-metallic deposits; the testing of ores and fuels; the examination and analysis of mineral specimens; together with the compiling of statistics relative to the mineral production of Canada, and the collecting of data with respect to our mineral resources.

Aside from the above programme, mention might be made of the continuance of the examination of the bituminous sand deposits of northern Alberta; the continued investigation of the building and ornamental stones of Canada; and the experiments being made in connexion with the metal cobalt, in an effort to find a greater field of usefulness for this mineral, so as to utilize the large quantities of cobalt residues which at present exist as a by-product: the result of the smelting of the silver ores of northern Ontario.

In addition to the above scope of work, the Mines Branch has inaugurated an investigation of the mineral waters of Canada, to determine, especially, their radioactive properties; has undertaken the analysis of oil and gas samples; and has taken up the examination of mine air samples with a view to assisting the mine owner to safeguard, to some extent, against serious explosions like those which have, of late, caused such a great loss of life, by giving him a definite idea of the nature and quantity of constituent gases that account for the atmospheric conditions of his mine.

Summary statements covering the specific work done by the different members of the staff will be found in succeeding sections of this report; and it is our intention, in the case of special investigations, to issue preliminary reports as early as possible, to be followed later, when completed data has been obtained, by final reports.

ORE DRESSING AND METALLURGICAL LABORATORIES.

The ore dressing and metallurgical laboratories of the Mines Branch, which are now equipped with the most modern machinery and apparatus, have, during the year, conducted tests, both on a large and small scale, with various Canadian ores and minerals.

The work accomplished in these laboratories has the approval of the mining industry of the country, since the tests carried out furnish the mine owner, in respect to his product, with the best and most economical method of ore dressing, and also aid him in solving certain metallurgical difficulties, which in the past prevented him from making his ore a marketable commodity.

To more fully cope with the many demands of the mining industry, an experimental roasting and sintering plant has been erected in conjunction with the above laboratories.

FUELS, AND FUEL TESTING.

The work of the Division of Fuels and Fuel Testing consisted in the continuation of the testing and detailed investigation of coals from the producing mines of western provinces; the investigation of peat bogs; and the investigation in the chemical laboratories of this division, of mineral samples of coals, peats, natural gas, oils, and—towards the close of the year—of mine air samples. This latter work was undertaken for the purpose of furnishing the coal mine operators with information concerning the composition of the air in the mine, so that defective ventilation might be remedied, and the serious accidents heretofore directly traceable to gassy mines be avoided.

Arrangements are being made to undertake an investigation, during 1915, into the feasibility of briquetting western lignites.

ZINC INVESTIGATION.

Investigation of Processes for Smelting Zinc Ores.

During the years 1912 and 1913, experiments in the electric smelting of zinc ores, on a small scale, were conducted for the Mines Branch at McGill University, under the supervision of Dr. Alfred Stansfield and Mr. E. Dedolph, and Mr. W. R. Ingalls of New York, acting in the capacity of consulting engineer to the Dominion Government.

Early in 1913, the experimenters developed an electric furnace that gave encouraging results: operating at the rate of 250 pounds of ore per twenty-four hours.

After making a series of test runs with this small furnace, it became evident that demonstrations on a larger scale were both necessary and desirable; accordingly, steps were taken to lease from the British Columbia Government, the old plant of the Canada Zinc Company at Nelson, B.C.

In accordance with instructions received from the Director of the Mines Branch, on October 2, 1913, Mr. G. C. Mackenzie proceeded to Nelson, B.C., to take control, for the Mines Branch, of the large-scale experiments to be undertaken.

Active construction was commenced shortly after his arrival; but owing to the difficulties of assembling material and supplies at a point so remote as Nelson, the furnace was not made ready until January of 1914.

The plant comprised a preheating furnace, an electric zinc furnace, and a small Wetherill furnace for making zinc oxide.

Experiments in the electric smelting of zinc ores, and in the fine concentration of zinc ores by means of the Wetherill furnace were carried on until the end of April, 1914.

In July, Mr. G. C. Mackenzie, in company with Mr. B. F. Haanel, and Messrs. Leverin and Parsons, of the Mines Branch, was sent to Hartford, Conn., to represent the Canadian Government at a test of the Johnson electric zinc furnace.

A detailed report of the whole zinc investigation, comprising experiments at McGill University; large-scale experiments at Nelson; and a test of the "Johnson" electric furnace is now being prepared by Mr. W. R. Ingalls, and will, in due course, be placed before the public.

SPECIAL METALLURGICAL INVESTIGATIONS.

Cobalt.

The special investigation of the metal cobalt, being conducted for the Mines Branch at the Research Laboratories of the School of Mining, Kingston, under the supervision of Dr. Kalmus, was undertaken—as stated in previous annual summary reports—to determine the properties of cobalt; to examine its adaptability as an alloy; and to find out some new commercial uses for the metal; all in an attempt to make marketable the large quantities of cobalt, as a by-product, resulting from the reduction of silver-cobalt ores: one of the greatest mineral assets of northern Ontario.

The results of the experiments, so far conducted, have been highly satisfactory, and it is found, as was suspected, that cobalt possesses, like nickel, physical properties which made it suitable as an alloy, thus giving the metal a value of considerable economic importance. Moreover, it has been found that cobalt can be economically used for plating purposes: the results obtained being more satisfactory, from a commercial standpoint, than those produced from nickel.

There have already been published by the Mines Branch—covering this field of experiments—the following technical papers, which are available for public distribution:—

"The Preparation of Metallic Cobalt by Reduction of the Oxide."
"A Study of the Physical Properties of the Metal Cobalt."

In addition to the foregoing the following papers are to be issued:—

"Electro-Plating with Cobalt and its Alloys." (In the press.)
"Cobalt Alloys of Extreme Hardness."
"Cobalt Alloys with Non-corrosive Properties."
"The Magnetic Properties of Cobalt, and of Fe_2Co."

On page 131 will be found a short report by Dr. Kalmus, on the progress of the investigations made during the year 1914.

ELECTROTHERMIC SMELTING OF IRON ORES.

In 1907, a report was published by the Mines Branch describing the experiments conducted at Sault Ste. Marie, Ont., under Government direction, in connexion with the smelting of Canadian iron ores by the electrothermic process. So great has been the demand for this publication, that the edition has been entirely exhausted. Moreover, many inquiries are still being received asking for information regarding the commercial results obtained from the electrolytic treatment of iron ores.

During the past few years, there has been considerable activity in the progress of electric smelting in European countries: especially in Norway and Sweden. In order to obtain information regarding the present status of the industry in Europe, Dr. Alfred Stansfield, Professor of Metallurgy, McGill University, was commissioned. early in 1914, to proceed to Sweden, and there obtain data for a report furnishing complete information regarding the electric smelting plants at present in operation, or under construction.

Dr. Stansfield's report, entitled "Electrothermic Smelting of Iron Ores in Sweden", is now in press, and will be available for distribution in 1915.

CHEMICAL LABORATORIES.

An important part of the work of the Mines Branch is that carried on in its chemical laboratories. All the laboratories are equipped with the most up-to-date apparatus and appliances. Each section is in charge of technical experts; and the important work being done is meeting the requirements of the general mining public.

The scope of investigations undertaken include the chemical determinations of metalliferous ores and non-metallic minerals: the physical examination of mineral specimens; and chemical analyses of coal, gas, and oil samples. As mentioned in the Summary Report for the year 1913, the necessary apparatus for water analysis has now been installed, and a specialist in water analysis engaged; hence, many samples of spring and mineral waters have been examined and reported upon during the year. Throughout the season of 1914, the working capacity of the different laboratories has been heavily taxed—although additional assistant chemists have been procured—in consequence of the increasing demands of those interested in the mining industry of the Dominion.

DOMINION ASSAY OFFICE, VANCOUVER, B.C.

In the Summary Report for 1913, attention was drawn to the fact that owing to the passing of an Order in Council, January 16, 1913, authorizing the abolition of the assaying and stamping charge of one-eighth of one per cent on the gross value of the gold and silver contained in deposits received at the Dominion of Canada Assay Office, Vancouver, B.C., there had been a considerable increase in the business done over that of the previous year.

That the above reform was much needed, is evidenced by the fact that, during the present year the amount of business exceeded that of 1913; the net value of deposits during 1914 was $580,625.94 in excess of that of 1913; and exceeded that of 1912 by $1,055,174.17.

During the year 1912, deposits of gold were made requiring 1,309 melts and 1,300 assays: including the assembling and remelting of the individual deposits after purchase, into bars weighing about 1,000 troy ounces, and the assaying of the same. The net value of the gold and silver contained in the deposits was $2,029,251.31.

COPPER METAL MINES.

During the year Dr. Wilson spent ten days in the Eastern Townships of Quebec, visiting the operating copper mines. A visit was also made to the Tetrault zinc mine near Notre Dame des Anges, Que. In the autumn he spent about a month visiting the mines and concentrating plants in the vicinity of Cobalt and Porcupine, northern Ontario, for the purpose of acquiring a knowledge of the present mining practice in these localities, and also to obtain data for use in the compilation of the volume on metal mines which will constitute the first part of the proposed new edition of the report on the Mining and Metallurgical Industries of Canada.

Various office duties assigned to Dr. Wilson required his presence in Ottawa during most of the year. Apart from his regular duties, I found it necessary to assign certain special work to him. Early in the year the report on Natural Gas and Petroleum Resources of Canada was placed in his charge. He has had general supervision over the preparation of the various maps and drawings for this publication, and found it necessary to re-write most of the sections dealing with the geology of the various provinces. He also read one copy of the proofs of this report.

IRON ORES.

Mr. Lindeman and a party of assistants spent the field season investigating iron ore deposits along the line of the Canadian Northern railway, between Winnipeg and Port Arthur.

The first part of the season was taken up in mapping some 8 miles of the Atikokan iron range: a narrow belt of iron-bearing rocks, following, in a general way, the course of the Atikokan river. The iron occurs as magnetite, pyrrhotite, and pyrite, in roughly lenticular bodies of varying size, scattered irregularly through the enclosing rock.

On the western part of the range, sulphides predominate to such an extent that, on some of the claims the iron-bearing mineral consists exclusively of pyrrhotite: a mineral not usually regarded as an ore of iron.

On the eastern part of the range, east of Sabawe lake, the Atikokan Iron Company has done considerable development work on some bodies of relatively pure magnetite. The mine is now idle, but during the period of operation, 90,608 tons of magnetite, averaging 59·8 per cent iron, and about 2 per cent sulphur, were shipped to Port Arthur, and used, after roasting, for the production of pig-iron in the blast furnace. Development work has disclosed considerable ore reserves on this property, some of it, however, very high in sulphur. The association of the ore with the enclosing rocks is here, as on the rest of the range, very irregular, so that it is difficult to make any tonnage estimates.

During the latter part of the season the various parties were engaged in surveying and mapping out the Matawin range. At Shabogna about 4 miles in length of the range was covered; and at Kaministikwia, about 1 square mile.

The Matawin range consists of jasper or other closely related siliceous material, with which is interbanded magnetite and hematite, in varying proportions. A very large quantity of this material is available close to transportation. It is, however, so low grade—usually less than 30 per cent of iron—that fine crushing and concentration, followed by briquetting or nodulizing, will be necessary before it can be made marketable. Taking into consideration the low iron content and the physical character of the ore, it does not seem feasible that such operations could be profitably undertaken at the present time.

SOME WESTERN ONTARIO IRON DEPOSITS.

The months of June, July, and August. of the field season of 1914, were spent by Mr. A. H. A. Robinson, making magnetometric and topographical surveys of the eastern part of the Atikokan iron range. At the end of August the party was moved to Kaministikwia, and similar work was carried on in that neighbourhood, in the townships of Ware and Conmee, until the middle of November.

Mr. R. E. Jamieson acted as field assistant throughout the season, and performed his duties in a highly satisfactory manner.

To Mr. J. Dix Fraser, general manager of the Atikokan Iron Company; Mr. F. Roda, superintendent at Atikokan mine; and to Mr. W. A. Matheson, barrister, Fort William, acknowledgment is due for many courtesies, and for much valuable assistance received during the progress of the work.

Complete magnetometric and topographical maps of the areas surveyed are now being prepared for reproduction, and will be published in due course.

LIMESTONES OF THE PROVINCE OF QUEBEC.

An investigation of the limestones and limestone industry in the province of Quebec was commenced this year by Mr. Fréchette. He spent the field season in examining outcrops and quarries along the Ottawa valley and the southern part of the Eastern Townships. Samples were secured representative of the limestones throughout these districts, analyses of which appear in his summary report, on p. 35. The field work will be continued during the season of 1915.

INVESTIGATING CERTAIN NON-METALLIC MINERALS.

Mr. de Schmid visited a number of the more important producers of barytes, manganese, infusorial earth, talc, etc., in order to secure for the Mines Branch first-hand information as to the status and immediate possibilities of these industries. This line of work will be continued during the ensuing season, and, if deemed expedient, the data obtained will be published in the form of brief individual bulletins on the different minerals.

INVESTIGATION OF THE SAND AREAS OF THE PROVINCE OF QUEBEC.

Mr. L. H. Cole, together with an assistant, was engaged during the field season of 1914 in the study of the sands and sandstones of the province of Quebec, with a view to determining their suitability for use in the building and manufacturing industries.

A special feature of this investigation was the search for sands suitable for glass manufacture, and for foundry purposes.

BITUMINOUS SAND OF NORTHERN ALBERTA.

The investigation of the bituminous sands of northern Alberta was continued during the season of 1914. A consideration of the results of preliminary field work undertaken during the preceding year indicated the desirability of securing further and more detailed information regarding these extensive deposits.

In order to demonstrate in a practical manner the possible value Canadian bituminous sand may have as a material for road construction, it was decided to lay a small section of experimental pavement in the city of Edmonton. For this purpose upwards of 60 tons of the sand was mined, sacked, and stored for shipment during the winter months.

Owing to the large number of exposures available, and to the wide variation in the bituminous sand itself, considerable care was required in the selection of the outcrop, or outcrops, from which a trial shipment could best be taken. Accurate core samples were, therefore, secured at a large number of points, and examined in a field laboratory. Finally, from results obtained in this manner, a selection of bituminous sand was made.

During the work of the preceding year, frequent exposures of clay were noted, and small samples collected at that time appeared to indicate the presence of bodies of economic value, hence a considerable number of larger clay samples were secured from representative outcrops for accurate laboratory determination. A number of samples of mineral water were also secured and forwarded to the laboratory at Ottawa.

In addition to the above, instrumental surveys were made of sections of a number of the streams tributary to the Athabaska.

BUILDING AND ORNAMENTAL STONES OF CANADA.

Dr. W. A. Parks, of Toronto University, has, under the direction of the Mines Branch, continued the investigation of the building and ornamental stones of Canada.

In previous Mines Branch Summary reports, reference was made to the progressive stages of this investigation, as conducted in the province of Ontario, the Maritime Provinces, and the province of Quebec. The field work for 1914 was confined to the province of Manitoba: the examination being part of the proposed investigation covering the three western provinces of Manitoba, Saskatchewan, and Alberta.

The information so far published in connexion with this investigation has been of great service to those interested in the stone-working industry. Data are furnished giving the localities producing the different varieties of stones, the character and magnitude of the deposits, the suitability of the products for various purposes, together with their commercial possibilities, judged from transportation, mining, and other conditions affecting production. In cases where quarries which formerly were large producers, but which, for various reasons, have now been abandoned, inquiries have been made, and suggestions furnished, with a view to remedying the cause that occasioned the removal of the product from the market.

Three volumes, describing the investigations so far completed, are now available for public distribution. Volume I, consisting of parts 1 and 2, contains a systematic investigation of the building and ornamental stones of Ontario; volume II, is descriptive of the deposits of the Maritime Provinces; while volume III, deals with the building and ornamental stones of Quebec. It is expected that the complete information regarding the building and ornamental stones of the western provinces will be obtained during the field season of 1915, and that a report covering the examination will be available for the public early in 1916.

INVESTIGATION OF PEAT BOGS.

During the field season, Mr. A. von Anrep, Peat Expert of the Mines Branch, examined a number of bog areas in the provinces of Quebec, Prince Edward Island, and Nova Scotia.

The work undertaken ascertained the extent, depth, and quality of the peat contained in the several bogs visited.

ORE DRESSING AND METALLURGICAL DIVISION.

The enlarged ore dressing laboratories, completely equipped for either large or small scale testing of Canadian ores, were practically completed during 1914.

The construction of a roaster building was started during April, and the building completed and partially equipped by December. This annex to the main testing laboratory consists of a steel and corrugated iron building, 58 feet long, and 30 feet wide, situated about 20 feet from, and at right angles to, the main laboratory.

Its equipment will consist of an 8-foot Wilfley roaster, specially adapted for testing purposes, and a Dwight and Lloyd duplex sintering pan, of the stationary type.

The roaster and pans for ore roasting and sintering will be driven by means of a 35-horsepower stationary engine. The fume and gas flues from the various apparatus will be connected with a large main, leading to a 24-inch by 60-foot self-supporting stack, placed outside of the building.

Additional apparatus, installed in the main testing laboratory during the year, consist of: two Plumb pneumatic jigs—one standard and one laboratory size; one belt-driven air compressor for supplying air to the pneumatic jigs; two James automatic ore jigs mounted in tandem; one laboratory apparatus for cyanide agitation tests; and one laboratory apparatus for the separation of minerals by oil flotation.

During the year, the staff of the laboratory completed a number of tests on various Canadian ores, of which the following may be mentioned: magnetite from central Ontario; banded iron ores from Algoma; magnetic sands from Quebec; zinc-lead and iron-copper ores from British Columbia; zinc-lead-copper ores from Quebec; and iron pyrites from northern Ontario.

Applications have been received, asking for tests to be made on United States ores; but inasmuch as the laboratories were installed for purposes of testing Canadian ores only, these applications had to be met with a somewhat heavy scale of charges, consequently the tests did not materialize.

In May, Mr. G. C. Mackenzie, Chief of the Division, returned from Nelson, B.C., where he had resided since the previous October, being in charge of the Zinc Investigation for the Mines Branch. In July, Mr. Mackenzie, in company with Mr. B. F. Haanel, assisted by Messrs. C. S. Parsons and H. A. Leverin, represented the Mines Branch at Hartford, Conn., during an experimental test run of the Johnson electric zinc process.

In October and November, Mr. Mackenzie visited the more important iron centres in the eastern and southern United States, where he collected information for the departmental committee preparing a special report on the iron industry—of which committee he is a member. During this tour, Mr. Mackenzie represented the Mines Branch at the annual meeting of the American Iron and Steel Institute held in Birmingham, Ala., at the end of October.

DIVISION OF MINERAL RESOURCES AND STATISTICS.

This division undertook the usual annual collection, compilation, and publication of statistics of mining the metallurgical production in Canada. In addition to the statistical reports, of which seven were published during the year, a revised edition of the report on "Economic Minerals and Mining Industries of Canada" was prepared for distribution at the Panama Pacific Exhibition.

Mr. McLeish, in charge of the division, prepared the reports on the production of Iron and Steel; Coal and Coke; Cement, Clay Products, etc., and all other non-metallic products, while Mr. Cartwright prepared the report on production of Gold, Silver, Copper, Lead, Nickel, Zinc, and other metals.

The death of Mr. Cartwright in October, left the division with an accumulation of work at the end of the year, the appointment of a successor not being completed until February, 1915.

A preliminary report on the Mineral Production of Canada during 1914, was, as usual, separately published two months after the close of the previous year, and is included as an appendix to this report, p. 197.

DIVISION OF EXPLOSIVES

Explosives Act.

On May 5, 1914, the Minister of Mines (Hon. Louis Coderre) gave notice in the House of Commons that he purposed introducing a Bill: "It being expedient to regulate and control the manufacture, importation, and use of explosives, also the construction, licensing, and occupation of premises to be used for the manufacturing and storage of explosives, and to authorize the making of official inquiries when accidents in explosive factories were reported."

On May 12, 1914, the new Explosives Bill—as prepared by Mr. Coderre, Minister of Mines—was read for the first time in the House of Commons.

On May 16, 1914, the Explosives Bill was in Committee of the whole House. The principal changes made from the original Explosives Bill 79 (1910-11), were in clause (*d*), section 2, in the interpretation of the words "explosive" and "magazine," and of the addition of a subsection (2) to section 7: allowing, under certain conditions, the blending of certain component parts of explosives, at or near the point of use, in which case the place where the blending is done shall not be deemed a factory or magazine, within the meaning of the Act.

In the regulations, a subsection was added governing the blending of the non-explosive components of an authorized explosive; and an addition was made to section 26, which reads:—

> Nothing in this Act shall relieve any person of the obligation to comply with the requirements of any license law, or other law or by-law of any province or municipality lawfully enacted, with regard to the storage, handling, sale, or other dealing with explosives, nor of any liability or penalty imposed by such law or by-law for any violation thereof.

On May 19, the Explosives Bill for Canada, passed its third reading in the House of Commons, without discussion; May 30, passed the Senate; and on June 12, 1914, the Bill was finally assented to, and became law. It is confidently expected that now the Explosives Act has become law, that action will be taken to put its provisions into force; to have the much-needed government inspection of explosives factories and magazines undertaken without delay; and, that the establishment of the explosives testing station will be proceeded with, at once, so that Canada will be in a position to determine the causes of the disastrous mining accidents that are constantly occurring. The following tabular statement shows the fatal and non-fatal accidents due to explosives in Canada during 1914, which has been compiled from information furnished by the Department of Labour.

The analysis of the accidents reported to the chief inspectors of mines from some of the provinces show that the larger percentage of accidents underground are due to explosions; especially is this so when metalliferous mines are under consideration.

Province of Ontario—

Fatal accidents due to explosives—(from 23rd annual report of the Bureau of Mines, 1914, page 55)—

Explosive accidents—	1913.	1912.
Premature explosion while loading or lighting holes..	8	0
Drilling into bottom of old or missed holes.	5	1
Asphyxiation from gases from explosives.	1	5
Picking or putting bar into old hole containing explosive.	0	1
	14	7

This shows that 43·7 per cent of underground fatal accidents were due to explosives: an increase of 100 per cent in the number of fatalities.

Province of British Columbia—

Accidents in metalliferous mines—

(See Quarterly Statement of Coal and Metal Mine Fatalities in British Columbia, compiled by Mr. Thomas Graham. Chief Inspector of Mines, Fourth Quarter, 1914. Table 4—Number of men killed in and around the metal mines of British Columbia, for the year 1914, with the fatalities classified according to cause.)

	1914.	1913.
Picking or drilling with unexploded powder..	1	3
Premature blasts..	5	1
Gassing or suffocation from powder fumes..	3	1
Returning on unexploded shots..	1	0
Falling in chutes, raises, winzes, etc..	1	2
Falls of ground..	3	3
Mine cars and haulage..	1	2
	15	12

This statement shows that 66·66 per cent of all fatalities, underground, in the year 1914, were due to explosives; and that 41·66 per cent were due to the same cause in 1913—an increase of 25 per cent in one year. It is evident from the above statements, that the necessity for putting the Explosives Act into force is of great urgency. The fatalities in Canada are so startling—when compared with those in countries where Explosives Acts have been enforced, owing to irresistible public opinion impressing on the Governments of those countries the duty of taking every precaution to safeguard human life—that action in carrying out the expressed legislative will of the people should not be much longer delayed.

A copy of the Explosives Act will be found as an appendix to this report, p. 217.

DOMINION OF CANADA ASSAY OFFICE, VANCOUVER, B.C.

The report of the business done at the Dominion of Canada Assay Office, Vancouver, B.C., during the year ending December 31, 1914, has shown a considerable increase over that of the previous year. This fact shows that the results anticipated by the passing of an Order in Council, in January, 1913, authorizing the abolition of an assaying and stamping charge of one-eighth of one per cent on the gross value of the gold and silver contained in the deposits, are being fully realized.

There were 166,148·83 troy ounces of gold and silver deposited with the Assay Office during the year 1914, as compared with 111,479·95 troy ounces for 1913, and 59,068·53 troy ounces for 1912: an increase over the two previous years, of 54,669·28 and 107,080·30 troy ounces, respectively.

In order to cope with the increase of business of the Assay Office during the year, it was found necessary to make the following changes in, and additions to, the staff:—

R. Allison, who was formerly assistant melter and janitor, was appointed as assistant melter, June 20, 1914.

E. A. Pritchett was appointed janitor, June 20, 1914.

- R. D. McLellan was appointed general assistant, June 29, 1914 (resigned September 11, 1914).
- H. E. Warburton was appointed temporary clerk, July 4, 1914; called out on military duty, August 10, 1914, left service October 3, 1914.

During the year 1912, deposits of gold were made, requiring 1,300 melts and 1,300 assays, including the assembling and remelting of the individual deposits after purchase, into bars weighing about 1,000 troy ounces each, and the assaying of the same. The net value of the gold and silver contained in the deposits was $2,029,251.31.

The above deposits received came from the following sources:—

Source.	Number of deposits.	Weight.		Net value.
		Before melting.	After melting.	
				$ cts
British Columbia	893	109,037·86	106,591·28	1,105,489 01
Yukon Territory	209	56,720·31	56,567·34	916,914 44
Alberta	1	30·08	29·70	511 55
Alaska	9	360·58	355·30	6,336 31
	1,112	166,148·83	163,543·62	2,029,251 31

Weight before melting	166,148·83	troy ounces.
" after "	163,543·62	"
Loss by melting	2,605·21	"
Loss percentage by melting	1·5680	

MISCELLANEOUS MATTERS.

ELECTRO-PLATING WITH COBALT.

It was mentioned in another section of this report that the investigation conducted in the Research Laboratories of the School of Mining, Kingston, in connexion with the metal cobalt, showed that for plating purposes this metal possesses qualities far superior to those of nickel.

In order to confirm the experiments made in the laboratory at Kingston, tests were made on a commercial scale at the plant of the Russell Motor Car Company, West Toronto. The results were highly satisfactory, and substantiated our statement as to the plating qualities of cobalt. In connexion with the above experiments, Mr. Barrows, foreman electroplater of the Russell Motor Car Company, writes to Dr. Kalmus, as follows:—

628 Dovercourt Road,
Toronto, November 2, 1914.

H. T. Kalmus, Esq.,
Queens University,
Kingston, Ont.

Dear Sir,—After preparing a cobalt plating solution according to your formula for bath IB, the same being equipped with cast anodes of 99·0 per cent cobalt, the bath being used daily during the past eight weeks plating a great variety of copper, brass, iron, steel, tin, German silver, lead and Britannia metal articles of different shapes and sizes, under exactly the same conditions as met with in general nickel plating at the factory of the Russell Motor Car Company, West Toronto, and after regarding the characteristics of this particular solution absolutely from a commercial viewpoint, I can heartily confirm any statement you have made to me regarding this remarkable solution.

The runs made have varied from 5 minutes to 24 hours, and in each case the bath has proved wonderfully efficient.

The cobalt plates obtained were smooth, white, and fine grained, very adherent and uniform. In fact the surface of these deposits after several hours run were so very smooth and uniform that a 4-inch cotton buff coloured them to a mirror finish quite easily. We use 14-inch and 16-inch buffs to colour 3-hour deposits of nickel.

To test the hardness of the cobalt as compared with nickel with reference to either buffing or polishing with emery, we plated strips of brass one-half the surface with cobalt, and one-half with nickel, always giving the nickelled portion the thickest plate, then by buffing or polishing across the two deposits, we found that invariably the nickel was removed from the brass before the cobalt, and in some cases in one-half the time.

Though so hard and firm, these plates colour beautifully, with little effort, and require the use of much less buffing composition than comparatively thin plates of nickel. Automobile parts of irregular shape were plated for 10 and 20 minutes, and finished on a 6-inch buff operated at 3,000 r.p.m. without the slightest evidence of a defect in the plating.

As a protective coating for iron or steel surfaces, I am convinced that a comparatively thin plate of cobalt will prove equally as effective as a thick plate of nickel from an ordinary double sulphate nickel bath, and the time and power required for the production of such plates is decidedly in favour of the cobalt.

The deposits are also very adherent, no difficulty having been experienced in this respect, although tests were made repeatedly by bending, hammering, and burnishing.

One of the weak points of several so-called rapid nickel-plating solutions which we have tried commercially, is their poor "throwing" powers, i.e., they do not deposit the nickel readily in the indentations or cavities of the cathode. The cobalt solution IB meets this requirement in a most efficient manner, the deposits on the distant portions of the cathode withstand the tests imposed in every case.

Another very noticeable feature of this solution which should commend itself to every practical plater and manufacturer of plated wares, is the extremely high current density at which this solution may be employed, without danger of pitting the plated surface.

As a further test we plated steel tubes of 1″ diameter, two hours, with a current density of 27 amps. per square foot, and then drew the tubes down to ⅝″ diameter, without injuring the deposit. Though extremely hard, the ductility of the deposited metal proved remarkable.

All our tests have been made in a still solution without agitation of any kind, and the plates were subjected to the most severe treatment considered practical for high-grade metallic coatings on the various metals heretofore mentioned.

We are also of the opinion that the anodes in the cobalt bath IB will remain free from coatings such as characterize average anodes used in nickel baths, and that the cost of maintenance will be practically nothing compared to double sulphate nickel solutions.

I can assure you that my experience thus far with these cobalt solutions has been intensely interesting, and I sincerely believe that their use commercially would revolutionize the art of electro plating such wares as are now nickel plated.

The simplicity of its composition, its self sustaining qualities, and remarkable speed of deposition, together with the several points mentioned previously, should appeal to the commercial requirements of this progressive age.

I remain,

Very truly yours,

(Sgd.) Walter S. Barrows,
Foreman Electroplater,
Russell Motor Car Co.,
West Toronto, Ont

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628 Dovercourt Road,
Toronto, December 1, 1914.

Dr. Herbert T. Kalmus,
Queens University,
Kingston, Ont.

Dear Sir,—After thoroughly testing cobalt plating bath XIII B, made according to your formula, I take pleasure in submitting the following report.

I found the bath very simple to prepare, and at once began to operate the solution with high current densities. The results obtained were exceedingly gratifying. Evidently bath XIII B will require no prolonged ageing treatment, as splendid white, hard, perfect deposits were obtained with extremely high current densities within three hours after bath was prepared. The experiments have been varied and the tests of plates severe and deliberate; the results have invariably been such as to cause me to regard cobalt bath XIII B the greatest achievement in modern electro plating improvements.

The operation of the bath is positively fascinating, the limit of speed for commercial plating is astonishing, while the excellence of the plates produced is superior to those of nickel for many reasons.

The efficiency of the freshly prepared solution together with the self sustaining qualities of the bath are without parallel in any plating solution of any kind I have ever used.

Thin embossed brass stampings were plated in bath XIII B for only one minute, then given to a buffer who did not know the bath existed and who was accustomed to buffing 1¼ hour nickel deposits on these same stampings. This man buffed the cobalt plates upon a 10″ cotton buff wheel revolving at 3,000 r.p.m. The finish was perfect with no edges exposed. These stampings have been plated in two dozen lots for one minute and from a total of 500 stampings we have found but three stampings imperfect after buffing. Each stamping is formed to a spiral after finishing without injury to the deposit. Grey iron castings with raised designs upon the surface were plated one minute in cobalt bath XIII B, then burnished with 400 lbs. of ⅛″ steel balls for ½ hour without the slightest injury to the cobalt coating, as was proven by a 36 hour immersion in 15 ozs. of water acidulated with 1 oz. of sulphuric acid.

While attempting to reach the limit of current densities which would be practical with this bath XIII B, I have plated brass automobile trimmings with a current density of 244 amperes per square foot. The pieces were plated in lots of 6, and a total of 100 were plated, buffed and ready for stock in 1 hour's time. No unusual preparation was made for the run and the work was performed by one man. Size of piece plated, 1½″ × 5″.

Automobile hub caps were plated three minutes in cobalt bath XIII B and buffed to a beautiful lustre of deep rich bluish tone by use of a 7″ cotton buff revolving at 1,200 r.p.m. The deposits were ample for severe treatment usually received by such articles. Comparative tests of these deposits were made as follows: Same style castings plated in double sulphate nickel solution one hour were suspended as anodes in a solution of equal parts muriatic acid and water, sheet lead cathodes were used and a current of 200 amperes at 10 volts passes through the bath. The nickel was removed from the castings in 30 seconds while 45 seconds' time was required to remove the cobalt plates.

The above mentioned plating tests were made with still solution, no form of agitation being employed. By aid of mechanical agitators these current densities could be greatly exceeded with highly satisfactory results.

These cobalt plates were very hard, white and adherent and coloured easily with slight effort.

Several plates were produced upon sharp steel surgical instruments; these instruments finished perfectly and owing to the hardness of the cobalt plate only a thin deposit was required to equal the best nickel deposits which we received as samples. Cobalt deposits should prove especially valuable for electro plating surgical instruments for this reason, non-adherent thick deposits of nickel being very dangerous for this class of work.

Owing to the unusual mild weather in this locality during the past month, I have not concluded test with cobalt plates on highly tempered nickel steel blades, but judging from appearances and various severe indoor tests, we do not hesitate to report success in this direction. A three minute deposit from bath XIII B resists corrosion equally as long as a one hour nickel deposit, the finish is even superior to nickel, while every test employed during the process of manufacturing the nickel plated article has proven equally ineffective with cobalt plates, therefore by reason of the effectiveness of thin cobalt deposits we believe cobalt plates should prove wonderfully efficient on skates, or any keen edged tool requiring a protective metallic coating.

The runs made with bath XIII B have varied from one minute to 15½ hours, and in each case the results were remarkable. Electrotypes were reproduced $\frac{1}{16}$″ thick. Electro-dies were faced with cobalt ⅛″ thick, the electrotype being graphite covered wax and lead moulds, while the dies were made on oxidized silver faced Britannia metal.

The deposits from cobalt bath XIII B were very adherent and pliable; by proper regulation of the current beautiful white, hard, tough plates may be produced quickly on any conducting surface.

The "throwing" powers of cobalt bath XIII B make possible its employment for plating deeply indented or grooved articles such as reflectors, channel bars or articles with projecting portion.

We also obtained the best plates with extremely high current densities, although plates finished with 75 amperes per square foot were of good colour and easily buffed. The production of excellent plates with a current density of 150 amperes proved particularly easy, and densities in this neighbourhood were employed for the greater portion of our tests.

Cobalt bath XIII B will produce excellent hard, white, tough plates absolutely free from pits or blemish at a current density of 150 amperes per square foot and under ordinary commercial conditions. This is fifteen times the speed of our fastest commercial nickel solution.

Furthermore, the anode tops and hooks remain free from creeping salts. The solution retains its original clean appearance and the anodes dissolve satisfactorily, no slime or coating formed, brushing or cleaning anodes therefore will be unnecessary. The anodes used with this bath were 98·75 per cent cobalt which were sent me from your laboratory. The bath at the commencement of our tests was strongly acid to litmus, and has remained unchanged throughout our experiments. The specific gravity of the solution when freshly prepared was 1·24 and is the same to-day.

The rich deep bluish-white tone of cobalt plates upon polished brass surfaces is particularly noteworthy; this feature should assist greatly in making cobalt deposits very popular for brass fixtures, trimmings and plumbers' supplies.

My experience with cobalt bath XIII B is by no means at an end. I intend to continue its use until present supplies are exhausted and then equip a larger bath if supplies are obtainable. As a commercial proposition I am satisfied it is wonderfully efficient and economical.

Taking into account the difference in cost of cobalt as compared with nickel, I am satisfied the metal costs for plating a given quantity of work with cobalt would be considerably less than for nickel plating a like quantity.

Furthermore the use of cobalt bath XIII B equipped with automatic apparatus for conveying parts through the bath would reduce the labour cost 75 per cent; such apparatus would be practical for a greater variety of wares than is now the case with nickel.

We cannot speak too highly of cobalt bath XIII B, and confidently believe its future history will surpass the history of any electro plating bath now in general use.

In conclusion, please accept my warmest congratulations upon your successes with cobalt solutions, and heartily appreciating the opportunity of testing these solutions, I desire to sincerely thank you, kind sir, for the benefits derived therefrom.

Very truly yours,

(Sgd.) Walter S. Barrows,
Foreman Electroplater,
Russell Motor Car Co.,
West Toronto, Ontario.

CERAMIC LABORATORY.

During the year 1914, provision was made for the establishment of a Division of Ceramics in connexion with the Mines Branch, and the necessary steps were taken to equip laboratories for the testing of clays, shales, and other materials used in our various ceramic industries. The need for this important departure is fully apparent when it is considered of what value a scientific investigation of our clay deposits will be to the public.

It has been known that there exist certain clay deposits in Manitoba, Saskatchewan, Alberta, Quebec, and Nova Scotia, and the character of their products has been examined as far as a chemical analysis is concerned. But before it can be fully decided whether a clay specimen is suitable for the manufacture of tiles, bricks, sewer pipe, or other clay products, a further investigation is necessary, which requires that the sample be submitted to a physical examination after it comes from the muffle.

Therefore, in order to ascertain, not only the true value of our known clay deposits, but also to assist in the opening up of new locations, the ceramic laboratory in charge of a well trained and experienced engineer, will materially advance the clay industry of the country. The clay operator will be furnished with complete information regarding his product, thereby enabling him to take advantage of the increasing demand for clay materials, which, during the last eight years, has advanced 170 per cent.

Moreover, it is expected that when the commercial value of the numerous deposits, now undeveloped, is ascertained, there will be available for the market, as the increasing demand requires, a sufficient supply of our domestic clays to offset, to a certain extent, the amount being imported, which in 1912 reached 38 per cent of a total consumption valued at $17,149,659.

The following tabulated statement of the production of clay materials for the year 1913, gives those interested some idea of the activity of the industry:—

Brick, common..	$5,917,373
Brick, pressed..	1,458,733
Brick, paving..	75,669
Brick, ornamental..	15,423
Fireclay and fireclay products..	142,738
Fireproofing..	461,387
Pottery..	53,533
Sewer pipe..	1,035,906
Tiles..	338,552
Kaolin..	5,000
Total value..	$9,504,314

TECHNICAL LIBRARY.

During the calendar year 1913, the growth of the Technical Library of the Mines Branch was such that, early in 1914, it was found necessary to move into larger quarters—on the ground floor. This transfer to more commodious quarters involved a complete reorganization of the library, and the addition of new stacks, filing cabinets, magazine rack, desk, reading tables, chairs, and other modern library equipment.

In order that the general arrangement and disposition of the books, etc., should be up-to-date, the librarian thoroughly investigated the conditions at McGill University, and, in addition, took a special course of study in librarycraft at Columbia University, New York. As a result of these investigations and studies in the art of library keeping, the books have been arranged according to the "Dewey" decimal system of classification; the most approved methods of library economy have been adopted; and a beginning has been made toward establishing a very thorough and comprehensive card catalogue.

Much time has been devoted to completing broken files of periodicals, and preparing the same for binding.

The efforts toward inaugurating exchange of publications with scientific institutions, both foreign and domestic, have met with most gratifying results: 57 exchanges have been secured during the year.

Accessions to the Library for 1914.

Three hundred and twelve volumes have been added by purchase; 339 volumes have been bound; 3,039 reports, monographs, memoirs, pamphlets, maps, and atlases from international Geological Surveys, and similar institutions, have been received, in exchange for the publications of the Mines Branch; 467 bulletins, journals, proceedings, and transactions of scientific societies, have been received in exchange; 12 periodicals have been subscribed for; and 13 periodicals received in exchange. Total number of accessions for 1914=4,377.

I have the honour to be,
sir,
Your obedient servant,
(Signed) **Eugene Haanel,**
Director of Mines.

INDIVIDUAL SUMMARY REPORT

METALLIFEROUS DIVISION.

I.

EXAMINATION OF CERTAIN COPPER DEPOSITS IN QUEBEC, OTHER METAL MINES, AND OFFICE WORK.

Alfred W. G. Wilson.

Chief of the Division.

Various duties assigned the writer necessitated his remaining in Ottawa the greater part of the year. During this time, in accordance with instructions, a revision was made of the report on the Petroleum and Natural Gas Resources of Canada, and also the paragraphs bearing on Pyrites, Copper, and Nickel, appearing in the second edition of the pamphlet on Economic Minerals and Mining Industries of Canada.

A considerable amount of attention was given to the organization of the different field parties of the Mines Branch, and also to the preparation of the Summary Report.

Very little direct progress has been made in the preparation of the manuscript of the report on the Copper Mines and Copper Mining Industry of Canada. An exhaustive card index and bibliography is being prepared, covering all the published references we have been able to find, relating to the occurrence of copper ores and copper minerals in Canada. The number of recorded references has not yet been counted, but it is probably in excess of seven thousand. The large amount of material to be studied and summarized, coupled with the numerous interruptions which appear to be unavoidable in office work in Ottawa, renders progress on this report very slow, and at the present time it is impossible to tell when it will be completed.

During the summer, two short field trips were made between the 15th of August and the 13th of October. About ten days were spent in the Eastern Townships of Quebec, on a visit of inspection to the mines at Eustis, Weedon, Eastman, and St. Gerard, for the purpose of bringing the information with respect to the copper-producing mines in Quebec up to date.

Before returning to Ottawa, a visit was made to the Tetrault zinc mine near Notre Dame des Anges, Quebec. The sulphide of zinc, sphalerite, has been found on this and on several adjoining locations, and much prospecting has been done during the past three years. On the Tetrault property a promising ore body has been partially developed, with four prospecting shafts, 58, 85, 92, and 57 feet, respectively, in depth. There was also a total of about 200 feet of drifting. The shafts were partially filled with water at the end of August, 1914, and little of the underground work was visible. Some of the ore recovered during development work has been hand-picked, and shipped to a chemical works.

The latter part of September and the first two weeks of October were spent in Northern Ontario, visiting the mines and concentrating mills in the vicinity of Cobalt and Porcupine, for the purpose of obtaining data for use in the Metal Mine volume of the projected report on the Mining and Metallurgical Industries of Canada.

II.

THE ATIKOKAN AND MATAWIN IRON RANGES.

E. LINDEMAN.

During the field season of 1914, field work was carried on from June 2 to November 15 on the Atikokan and Matawin iron ranges. The work consisted of magnetometric and topographical surveys, conducted in connexion with a geological examination of the ore deposits. The writer was ably assisted in this work by Messrs. A. H. A. Robinson, H. Kennedy, and M. Meikle, each being in charge of a party of five men. The months of July, August, and September were spent by the writer, in Ottawa, preparing a report on the iron ore deposits of Canada for the Iron Committee, appointed by the Government in September, 1914.

ATIKOKAN IRON RANGE.

Between Kawene and Atikokan stations on the Canadian Northern railway, outcrops of magnetite and pyrrhotite have been found, intermittently, along the Atikokan river, for a distance of about 16 miles. Numerous locations have, in the past, been taken up, and a considerable amount of prospecting and development work has been done on some of these claims. Amongst the locations which have attracted most attention are E 10 and E 11. These lie east of Sabawe lake. They were formerly known as the McKellar property, and now as the Atikokan Iron Company's mine. Mining operations have been carried on here at intervals since 1907, and 90,000 tons of iron ore are reported to have been shipped. The mine is connected by a branch line, 3 miles long, with the Canadian Northern railway, at Iron Spur, the distance from this junction to Port Arthur being 128 miles. A description of the mine, and the eastern part of the range, is given by Mr. A. H. A. Robinson in his summary report.

Locations R 400 and R 401—Location R 400 is situated about 2 miles west of Sabawe lake, and about 1½ miles northwest of Hematite station, on the Canadian Northern railway.

The claim is 40 chains long and 20 wide, and adjoins claim 401, to the west, which has about the same area. Both claims are bounded by the Atikokan river, R 400, on its southwest corner, and R 401, along the whole extent of its south side.

The two claims are traversed from east to west by diorite intrusives, in which magnetite, pyrrhotite, and iron pyrite occur concentrated into irregular lenses or are found disseminated in small amounts throughout the rock. Outcrops of greenstone, carrying some magnetite and sulphides of iron, are first met with about 1,100 feet west of the boundary line, between claims 400 and 401. From this place the iron-bearing rock may be traced through claim 400 into 401, a distance of 2,200 feet, being specially well exposed near the boundary line, between the two claims where the south side of the ridge descends abruptly towards the river. About 100 feet west of this line, and at an elevation of about 35 feet above the river, a tunnel has been driven into the steep hillside. The length of the tunnel is 74 feet. About 37 feet in from its mouth a vertical shaft, 52 feet deep, has been sunk. The rock formation exposed by the tunnel consists of greenstone, with irregular patches of magnetite mixed with pyrrhotite, or magnetite and pyrrhotite disseminated throughout the diorite.

In addition to this development work, several trenches and cross-cuts have been made at various points along the ridge. The principal open-cut on lot 400 is 1,050 feet northeast of the tunnel, exposing the iron-bearing formation across the hill for a distance of 32 feet. The character of the formation is here the same as that seen in the tunnel. An average sample taken along the cut gave the following analysis:—

Fe	53·10	per cent
SiO_2	11·20	”
S	3·87	”
P	0·015	”

A similar open-cut has been made on the hillside towards the river, about 450 feet west of the tunnel, on claim 401. The cut is 45 feet long, 4 feet wide, and 6 feet deep, trending north and south, and exposing a good magnetite in places, but also sulphides of iron and rock. An average sample taken along the cut gave the following analysis:—

Fe	48·80	per cent
SiO_2	16·32	”
S	3·84	”
P	0·088	”

Going westward from this cut, the country slopes gently, and no outcrops can be seen for a distance of about 1,000 feet. At this point a narrow ridge rises above the surrounding muskeg, and extends along the river for a distance of 2,300 feet. The greenstone is well exposed on this ridge, often exhibiting a rusty appearance, owing to the oxidation of iron sulphides with which the rock is heavily charged.

The following analysis represents an average sample taken across the formation at the western end of the ridge. The length of the trench from which the sample was taken is 54 feet:—

Fe	38·56	per cent
SiO_2	41·97	”
S	3·50	”
P	0·020	”

Crossing the Atikokan river, and going westward on claim 212 X, no magnetic attraction is noticed for a distance of 1,500 feet, when another magnetic area is met with, which has a total length of 2,800 feet, and extends from claim 212 X into R 403. The only exposure of the iron bearing formation on claim 212 X, is in an open pit near its western boundary line, where a considerable amount of pyrrhotite has been exposed. Farther west, on claim 403 R, the country becomes higher, and the iron bearing formation is found along a ridge rising in places 60 to 70 feet above the river. Numerous trenches and test pits have been made along this ridge, exposing in most cases pyrrhotite with some magnetite, and showing the iron bearing minerals to occur in irregular lenses throughout the diorite. The width of the area within which these lenses occur may roughly be estimated at 100 feet. An average sample taken from one of the trenches gave the following analysis:—

Fe	51·00	per cent
SiO_2	2·58	”
S	15·28	”
P	0·025	”

West of this mineralized area there is no indication of any iron ore deposits for a distance of one mile, or before claim 139 X is reached. This claim lies north of the Atikokan river, near mile post 135 on the Canadian Northern railway. The iron bearing formation is here exposed in numerous places along a high ridge which extends from claim 139 X into the adjoining claim 138 X. It consists of the same type of diorite as found on the other claims previously described, with magnetite and pyrrhotite disseminated throughout the rock. In places, the pyrrhotite and magnetite are found concentrated into irregular lenses or pockets. The iron and sulphur content of the ore varies considerably. Diamond drill records kindly furnished the writer by Mr. R. H. Flaherty show the iron content to range from 62 to 38 per cent with a variation in sulphur of from 3 to 25 per cent. The phosphorus content is generally low, ranging from 0·006 to 0·045 per cent, while the silica varies from 2 to 16 per cent.

Judging from the magnetometric survey, the length of the area within which pyrrhotite and magnetite may be found on these two claims is roughly estimated at 2,600 feet, with a maximum width of about 250 feet.

A few hundred feet farther west several small detached magnetic areas indicate the presence of pyrrhotite and magnetite. They are, however, of too small extent to be of economic interest.

Iron location near mile post 140.—This property lies about 5 miles west of Hematite station near mile post 140, and about $2\frac{1}{2}$ miles east of the Atikokan station on the Canadian Northern railway.

The area covered by the summer's field work is 1 mile long and 2,000 feet wide; the greater part of which is occupied by basic igneous rocks of the diorite type. In the southern part a typical micaceous slate is well exposed along the railway for a distance of about 2,000 feet. The general strike of the slate is N. 72° E., with an almost vertical dip.

The chief iron-bearing minerals are iron pyrite, with some magnetite. They are found disseminated in small amounts throughout the diorite in several detached areas. These areas generally show a rusty appearance owing to the oxidation of the iron pyrite. The principal occurrence is on a hill about 900 feet northwest of mile post 140. The red brown gossan can here be traced along the top and flank of the ridge for a distance of 600 feet. At the west end a trench, 50 feet long and 5 feet deep, has been made across the top of the hill, exposing a fine grained rusty looking basic rock, with magnetite and iron pyrite disseminated throughout the mass. An average sample taken along the trench gave the following analysis:—

Fe	39·50	per cent
SiO_2	20·10	"
S	5·37	"
P	0·021	"

Judging from the magnetometric survey, the total length of this mineralized area is about 830 feet, with a maximum width of 110 feet. The magnetic attraction is, however, very irregular within the area, indicating an irregular and pockety distribution of the magnetite in the diorite, and giving little encouragement for finding any ore body of economic importance.

About 800 feet west-southwest of the area just described, another occurrence of gossan outcrops on the top and along the south side of a small hill. It has a length of 250 feet with a width of about 50 feet. Crossing the Atikokan river, several small areas showing the same rusty looking rock are found on the steep hill immediately south of the railway track. Several trenches and test pits have been made on this hill, but without revealing any ore body of economic interest.

COMMERCIAL POSSIBILITIES OF THE ATIKOKAN IRON RANGE.

With various intervals, mining operations have been carried on at the Atikokan mine since 1907, and about 90,000 tons of magnetite have been shipped by the Atikokan Iron Company to its blast furnace in Port Arthur, and there smelted after first being roasted. The average iron content of the crude ore is reported by the company to be 59·8 per cent, with a sulphur content of 2·01 per cent.

On the western part of the range, i.e., on the properties west of Sabawe lake, the conditions are somewhat different. The ores here are generally much higher in sulphur, and on some of the claims the iron-bearing mineral consists exclusively of pyrrhotite, which mineral is not generally looked upon, at the present time, as a source of iron ore. But assuming, as claimed by certain parties, that it is metallurgically possible to roast these high sulphur ores in specially constructed furnaces, down to a sulphur content of less than one-half of 1 per cent, the cost of roasting the ore, added to that of mining, which, owing to the irregular and pockety character of the ores is likely to be rather high, would, in all probability, render it impossible to carry out such a process economically at the present time.

MATAWIN IRON RANGE.

This range, as far as it has been traced, has a total length of 35 or 40 miles, and extends from Greenwater lake eastward, south of Lake Shebandowan, to Kaministikwia on the Canadian Pacific railway. The iron formation consists of interbanded jasper and other closely related siliceous material, usually magnetite, although at times the iron-bearing mineral associated with the jasper is hematite. The iron range is not continuous for all this distance, but forms a series of detached areas or lenses of various size, which, generally, have an east and west trend, with an almost vertical dip. The distance between the various areas of the iron formation varies considerably, but may reach several miles in places.

The part of the range which has so far attracted most attention, is in the vicinity of Shabaqua station, on the Canadian Northern railway, about 53 miles west of Port Arthur, where a large number of claims have been staked on both sides of the Matawin and Shebandowan rivers.

The latter part of the field season of 1914 was devoted to this locality, and a topographical and magnetometric survey made of the following claims: W 216; W 217; W 218; W 219; W 220; W 221; and W 223.

Location W 216 is situated on the south side of Matawin river where the Shebandowan river flows into it. The Canadian Northern railway traverses nearly the whole north part of the location.

The iron formation is well exposed on a hill about one-fourth of a mile south of the railway track, and about 800 feet west of the eastern boundary of the claim. It consists of a fine grained bluish grey siliceous slate, through which exceedingly fine crystals of magnetite—hardly visible to the naked eye—are disseminated. The average iron content of the formation is very low. Two samples taken at the east and west ends of the exposure and representing a width of 57 and 35 feet, respectively, gave the following analyses:—

	No. 1.	No. 2.
Fe..	20·99	20·90
SiO_2..	61·26	63·04
S..	Trace.	0·085
P..	0·015	0·087

Going westward, several other smaller exposures of iron formation can be seen on this claim. The iron bearing series is, however, of even a leaner character than that previously described, and may more appropriately be classed as ferruginous slate. Sufficient magnetite is present in the rock to enable it to be traced across the claim by magnetic readings, but from an economic point of view it is of no importance.

Location W 217 is situated due west of W 216. It is heavily drift covered and no outcrops of the iron bearing series are visible, but by magnetometric readings it can be traced across the whole width of the claim, i.e., about half a mile.

Location W 218 is due west of W 217, and is 1 mile long and half a mile wide. The iron formation is prominently exposed near the western boundary line of the claim, on a big cliff rising about 25 feet above the surrounding country, and having an elevation of 1,450 feet. The character of the iron formation is similar to that previously described, although its iron content seems to be somewhat higher as shown by the following analysis representing an average sample taken across an outcrop 47 feet wide near the cliff:—

Fe	29·49 per cent.
SiO_2	52·14 "

Another sample taken about 500 feet farther east, and representing an outcrop 17 feet wide, give the following analysis:—

Fe	30·25 per cent.
SiO_2	51·25 "

Judging from the magnetometric readings, and a few outcrops, the iron bearing formation can be traced across the whole width of the claim, reaching its maximum width of 300 feet about 700 feet east of the western boundary line of the claim.

Claim W 219 adjoins W 218 to the west. It is 1 mile long and half a mile wide, and is divided into two parts by the Matawin river. The iron-bearing formation can be traced, by magnetic readings, from the eastern boundary line of the claim westward to the Matawin river, a distance of 1,200 feet. It is well exposed in a ravine south of the old camps, and yet more prominently along two small knolls farther west, near the river. The iron formation is leaner than that of the previous claim described. Four samples taken at various points across the formation, and representing a width of 47, 75, 52, and 33 feet, respectively, gave the following analyses:—

—	No. 1.	No. 2.	No. 3.	No. 4.
Fe	13·38	24·28	17·31	17·81
SiO_2	70·03	58·78	66·70	65·05

For a distance of about 1,700 feet west of the Matawin river, the magnetometric survey gives no indication of any continuous iron formation, and a few very small scattered magnetic areas are all that can be found on this part of the claim.

But at a point about 350 feet west of the boundary line between W 219 and W 220, the magnetic attraction comes in again, hence, westward, the iron formation can be traced by outcrops and magnetic readings, with one or two small intervals, through claims W 220, W 221, and W 222, a distance of 7,000 feet. Judging from the magnetometric survey the width of the iron-bearing formation on claim W 220 may be roughly estimated at 50 to 200 feet. It increases, however, considerably on claim W 221, and reaches a width of over 1,000 feet near the boundary line between W 221 and W 222. Going farther west on W 222, the iron formation decreases again in width, being 100 to 400 feet wide.

On claims W 221 and W 222, the iron formation consists chiefly of a fine grained siliceous hematite, interbanded with siliceous material, black and red chert. Judging from the magnetic character of the formation, magnetite is also present. Four samples, taken across the exposed formation at various points, gave the following analyses:—

—	No. 1.	No. 2.	No. 3.	No. 4.
Fe	25·07	29·35	30·89	27·86
SiO_2	54·20	48·76	46·34	49·44

The width of the exposures from which the samples were taken were 100, 35, 36, and 47 feet, respectively. Samples Nos. 1 and 2 are from claim W 221; 3 and 4 from W 222.

From what has been said in regard to the extent of the iron formation on these seven claims, it is evident that a large quantity of low grade ore is available, all of which, however, requires fine crushing and concentration, with subsequent briquetting or nodulizing before it can be made marketable. To carry on such an operation profitably, at the present time, does not seem feasible, owing to the low iron content of the ore, and the extreme fineness to which the grinding would have to be carried before a satisfactory separation could be attained. The iron formation of the western claims, W 221 and W 222, offers also another objectionable feature for magnetic separation, on account of the iron-bearing mineral being present there, chiefly in the form of hematite.

III.

ATIKOKAN IRON RANGE.

A. H. A. Robinson.

The Atikokan iron range is situated in the district of Rainy River, not far west of the boundary of Thunder Bay district, and lies close to, and just to the north of, the main line of the Canadian Northern railway between Port Arthur and Winnipeg. Starting about a mile and a half east of Atikokan station, it can be traced eastward as a broken chain of iron deposits, following the general course of the Atikokan river for a distance of some 16 miles; the outcrops often standing out on low hills in the river valley.

The eastern portion of the range, with which the present report deals, extends from Sabawe lake—a lake expansion of Atikokan river—in a direction N. 87° 27′ E. (astronomical), for a distance of a little over 3 miles, to Attraction lake, a small stagnant pond lying a short distance north of the river.. Starting at Sabawe lake, a small, unimportant outcrop of the iron formation is found on the lake shore, just south of the mouth of the river. Eastward from this outcrop no continuous attraction is found for a distance of half a mile, when the compass needle again indicates the presence of the range beneath the covering of drift. Hence, eastward, the magnetic attraction is continuous—with one or two minor breaks—to Attraction lake. Between Sabawe and Attraction lakes the magnetic belt crosses the following mining claims, given in order from west to east:—24 E, 23 E, 10 E, 11 E, 12 E, 25 E, and 26 E.

A spur line, 3 miles long, connects the Atikokan Iron Company's workings on E 10 and E 11 with the main line of the C.N.R. at Iron Spur, 128 miles west of Port Arthur.

The district traversed by the iron range shows considerable variety in the character of the rocks which occur in it. According to Dr. A. C. Lawson (G. S. C., No. 24, Geological Series), the iron-bearing belt lies at, or very close to, the contact between a Keewatin series of greenstones, felsites, quartz-porphyries, etc., and their schistose equivalents, and a later sedimentary—Seine—series made up largely of dark, grey and grey-green, micaceous quartzites, and greywackes, grading into sericitic schists. In the immediate vicinity of the iron-bearing belt, on either side of it, the rocks exposed are, at this eastern end of the range, so fine grained and schistose as to make the determination of their original character difficult. A short distance to the north of the ore, however, they are found to grade into schistose Keewatin greenstones, while on the other side, to the south, greywackes and quartzites become distinctly recognizable at a short distance from the ore. Both ore and schists have a vertical dip. The strike of the ore belt is everywhere parallel to the schistosity of the enclosing rocks, and maintains a remarkably straight course of about N. 84° 27′ E. for the three miles between Sabawe and Attraction lakes.

With regard to the origin of the Atikokan ore, it has been usual to refer it to the pegmatite type; it is supposed to have been brought to, or near, the surface in magmas, and extruded from them much as in the case of pegmatite dikes. Dr. A. C Lawson, who has made the most recent detailed study of the geology of the region, suggests, however, a different mode of origin. His idea is, that the iron was derived from the weathering of Keewatin rocks, in pre-Seine or early Seine time, and was afterwards concentrated either in bogs on the old Keewatin surface, or by underground circulation after the burial of the weathered and iron-rich surface by the Seine sediments.[1]

Atikokan Iron Mine: Mining Locations E 10 and E 11.

The Atikokan iron ore deposits were discovered in 1882, by Jim Shogonosh, an Indian trapper in the employ of Mr. G. McLaurin, of Savanne. The latter interested Messrs. McKellar Bros., of Fort William, who applied for, and acquired from the government what is now known as mining locations E 10 and E 11. In 1905, the property was taken over by the Atikokan Iron Co., of Port Arthur, Wm. Mackenzie president, and in 1906-7 the same company built a blast furnace at Port Arthur to use the ore from their Atikokan mine. The first shipment of ore was made in May, 1907, since when shipments have been made as follows:—

1907	19,105 tons.
1908	nil
1909	14,014 "
1910	26,318 "
1911	30,737 "
1912	434 "

A total of 90,608 tons mined and shipped since the mine was opened.

All the ore was sent to Port Arthur, and, after roasting to remove sulphur, was used in the company's blast furnace there, for the manufacture of foundry pig-iron. No ore has been mined since 1912.

As disclosed on locations E 10 and E 11, the range outcrops as a steep narrow ridge of green schist, with which are inter-bedded irregularly-shaped, roughly lenticular, overlapping bodies of magnetite or magnetite and pyrite. This hill, along which the ore outcrops, is 3,800 feet long, 400 feet wide at the widest place, and has a maximum elevation above the swamp that surrounds it on all sides, of about 100 feet. The rock immediately in contact with the ore is partly a hornblende chlorite schist, partly a massive pyroxenite, often heavily impregnated with pyrite nad pyrrhotite. Beds of a greyish-white chert are also found intercalated with the ore and schist, and, in the ore bodies on the north side of the ridge especially, a dark green slate interlaminated with magnetite in narrow bands, is often found. To the north the ore-bearing belt is bounded by a wall of highly schistose, light-coloured acidic rock.

These two locations, E 10 and E 11, are the only ones on the eastern end of the range on which any extensive development has been done, or from which commercial shipments have been made; they, together with E 12, are the property of the Atikokan Iron Co. The development work consists of: five tunnels, A, B, C, D, and E, named in order from west to east; three shafts Nos. 1, 2, and 3, also in order from west to east; and six diamond drill holes. The first four tunnels, A, B, C, and D, have been driven through the hill from side to side a little above the level of the swamp; the fifth, E, penetrates it from the south for about 100 feet. The shafts are all on the south side of the hill and from the bottoms of Nos. 2 and 3 cross-cuts have been driven north through the ore, at depth of 150 and 126 feet respectively below the level of the tunnels. The No. 1 shaft, sunk on a band of highly pryritiferous ore, was stoped at a depth of 47 feet.

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[1] "Archæan Geology of Rainy Lake Re-Studied," by A. C. Lawson. G. S. C. No. 24, Geological Series.

Following, are particulars of sections through the hill at the different tunnels—the sections and analyses being taken from the Atikokan Iron Company's records:—

Tunnel A, 400 feet from the west end of the ridge on E 10.

Section, south to north.

Ore and pyrite	Iron	18·26 per cent.	7·0 feet
	Silica	6·06 "	
	Sulphur	18·81 "	
	Phosphorus	0·009 "	
Rock			27·0 "
Banded magnetite and pyrite	Iron	45·1 per cent.	26·0 "
	Silica	4·90 "	
	Sulphur	14·93 "	
	Phosphorus	0·060 "	
Rock and lean ore			11·5 "
Mixed ore and rock	Iron	42·3 per cent.	34·5 "
	Silica	18·6 "	
	Sulphur	6·38 "	
	Phosphorus	....	
Rock			5·0 "
Ore	Iron	51·25 percent.	8·0 "
	Silica	15·40 "	
	Sulphur	1·30	
	Phosphorus	....	
Rock			48·0 "

Tunnel B, 1,185 feet east of *A*.

Section, south to north.

Rock			22·0 feet.
Ore and pyrite	Iron	46·8 per cent.	12·0 "
	Silica	16·6 "	
	Sulphur	12·3 "	
	Phosphorus	0·34 "	
Rock			9·0 "
Ore	Iron	52·00 per cent.	8·0 "
	Silica	13·26 "	
	Sulphur	4·77 "	
	Phosphorus	0·85 "	
Rock			3·0 "
Ore	Iron	50·60 per cent.	24·0 "
	Silica	15·34 "	
	Sulphur	6·75 "	
	Phosphorus	0·20 "	
Rock			13·0 "
Ore	Iron	59·00 per cent.	22·0 "
	Silica	8·30 "	
	Sulphur	2·17 "	
	Phosphorus	0·09 "	
Rock			26·0 "
Ore	Iron	45·92 per cent.	9·0 "
	Silica	19·40 "	
	Sulphur	1·41 "	
	Phosphorus	....	
Rock			27·5 "
Ore	Iron	58·39 per cent.	5·0 "
	Silica	9·97 "	
	Sulphur	2·78 "	
	Phosphorus	0·135 "	
Rock			5·0 feet
Ore			1·5 "
Rock			30·0 "

Tunnel C, the main working tunnel, situated 500 feet east of *B,* about half-way along the ridge close to the line between E 10 and E 11.

Section, south to north.

Rock			61·00 feet.
South ore body (stoped)	[1] Iron	60·00 per cent.	47·0 "
	Silica	8·50 "	
	Sulphur	2·01 "	
	Phosphorus	0·11 "	
Rock			62·0 "
North ore body	[2] Iron	47·68 per cent.	42·0 "
	Silica	17·51 "	
	Sulphur	2·30 "	
	Phosphorus	0·193 "	
Rock			60·0 "

[1] Average of three years' shipments.
[2] Average of five analyses.

Tunnel D, 450 feet east of *C,* starts from a small open-cut on the south ore body.

Section, south to north.

South ore body (stoped)	[1] Iron	59·57 per cent.	40·0 feet.
	Silica	8·41 "	
	Sulphur	2·17 "	
	Phosphorus	0·11 "	
Greenstone, chert and chlorite schists			62·0 "
North ore body	[2] Iron	59·40 per cent.	33·0 "
	Silica	8·10 "	
	Sulphur	0·61 "	
	Phosphorus	0·041 "	
Rock			97·0 "

[1] Average of four analyses.
[2] Average of five analyses.

Tunnel E, 510 feet east of *D,* has been driven 98 feet into the hill.

Section, south to north.

Rock			10·0 feet.
Ore with pyrite	[1] Iron	46·86 per cent.	47·0 "
	Silica	15·90 "	
	Sulphur	12·90 "	
	Phosphorus	0·169 "	
Rock			19·0 "
Ore	[2] Iron	56·18 "	17·0 "
	Silica	11·05 "	
	Sulphur	1·97 "	
	Phosphorus	0·157 "	
Rock, to end of tunnel.			

[1] Average of five analyses.
[2] Average of three analyses.

The ore is a hard, dense, magnetite, difficult to mine, and refractory in the blast furnace. Associated with it are pyrite and pyrrhotite in varying quantities, also a little chalcopyrite. The sulphur content is high, running from 2 per cent to 25 per cent and over, so that all the ore has to be roasted before it can be used for the manufacture of pig-iron. Phosphorus is above the Bessemer limit, and nickel is present in minute quantities.

An average analysis of all shipments to date, totalling 90,608 tons, is as follows:—

Silica	8·68 per cent.
Alumina	1·51 "
Metallic iron	59·85 "
Phosphorus	0·11 "
Manganese	0·11 "
Lime (CaO)	3·00 "
Magnesia (MgO)	2·54 "
Sulphur	2·01 "
Titanium	nil
Copper	0·12 "
Nickel	0·11 "

The great bulk of this ore has come from an open-cut about 300 feet long, 40 feet wide, and 60 feet deep, on the south side of the hill at *C* tunnel. Smaller amounts have come from a small open-cut at the south entrance to *D* tunnel and from development work.

As regards the quantity of ore available, there are, without doubt, some millions of tons scattered through the hill. But as it occurs in bodies very irregular both in their outlines and in their distribution through the enclosing rock, so that the relative proportions of rock and ore over a given width of the ore belt vary greatly within short distances, any accurate estimate of available tonnage is difficult. In addition, the variable and in places very high sulphur content, a matter seriously affecting the value of the ore, would have to be taken into consideration in any estimate of commercial tonnage.

Mining Locations E 12, E 25, and E 26.

From the east end of the ridge on E 11, the ore-bearing belt has been traced eastward over swamp and rock, across mining locations E 12, E 25, and the greater part of E 26. Judging from the magnetometer readings, it has, over this stretch, a width of from 40 to 75 feet, and is continuous, with the exception of two short breaks, for the entire distance.

Very little work has been done on this part of it, so that while outcrops of the decomposed iron-stained rocks of the iron range are of frequent occurrence, actual exposures of magnetite are small and unsatisfactory, and no opportunity is afforded of getting sections through the magnetic belt, or ascertaining the width of ore in it. Judging by what can be seen, however, it is probable that any ore bodies will be found to be much smaller than those occurring on E 10 and E 11, and that the sulphur content will be at least as high as it is there.

Mining Location E 23.

From the westerly end of the ridge on E 10, where it disappears under the swamp, the ore-bearing belt has been traced westward for 2,400 feet, under deep drift all the way. This takes it about two-thirds the way across E 23.

As there are no outcrops, nothing definite is known about either the quantity or quality of the ore here. By referring, however, to the section at tunnel A—the nearest good exposure on the ore-bearing belt—it will be seen that at that point the ore had become highly sulphurous nearly all the way across the belt.

KAMINISTIKWIA.

South of Kaministikwia, a station on the Canadian Pacific railway, 28 miles west of Port Arthur, along both sides of the Kaministikwia river, in the townships of Ware and Conmee, there occur numerous outcrops of banded iron ore and jasper. These from part of what is sometimes known as the Matawin iron range, a belt of banded iron formation which runs from Greenwater lake eastward, south of Lake Shebandowan, to Kaministikwia—a distance of 30 or 40 miles. For the purpose of outlining the areas actually underlaid by this iron-bearing material, a magnetometric and topographical survey of the district was undertaken, and about one square mile of it between Kaministikwia and Mokomon—a station on the Canadian Northern railway 2 miles south of Kaministikwia—was covered during the season. Maps showing the results of this survey are now being prepared for publication.

The iron formation consists of jasper, or other closely related siliceous material, with which is interbanded narrow seams of mixed magnetite and hematite. The magnetite-hematite bands run usually from a mere film, up to an inch in width, and form but a small proportion of the whole formation. A number of average samples taken across the outcrops in different parts of the field yielded, on analysis, 16 to 30 per cent of iron, and 50 to 70 per cent of silica. Nowhere was the iron found concentrated in sufficiently large bodies to be workable. Picked samples of the magnetite-hematite bands freed from jasper are of fair grade and quality. They occur too sparingly, however, to afford much promise of any scheme for their mechanical concentration being commercially profitable.

TOWNSHIP OF MISCAMPBELL.

In the early part of August, a visit was paid to a reported discovery of iron ore near Fort Frances, Ont., on lots 4 and 5 in the second concession of the township of Miscampbell.

As far as can be seen on the comparatively small outcrops exposed, the deposit consists of large blocks of a low grade iron-bearing formation included in eruptive granite. The included material consists of finely granular magnetite and quartz in more or less distinct bands. It is distinctly crystalline, and rather friable in character. Crystals of pyrite and garnets are found scattered through it, in small amounts.

Several diamond drill holes were put down on the property by Fort Frances parties, but nothing of importance was found.

Should large continuous bodies of this material be found so located as to be easily and cheaply mined, it might, on account of its granular, friable nature, offer possibilities as a concentrating proposition. Found here, however—as inclusions in granite—it gives little promise of commercial value.

NON-METALLIFEROUS DIVISION.

I.

LIMESTONES OF THE PROVINCE OF QUEBEC.

HOWELLS FRÉCHETTE.

Chief of Division.

In the summer of 1914, an examination of the limestones throughout the province of Quebec was begun, with a view to investigating their economic importance and their suitability for various uses in the manufacturing industries. Samples were collected from over a hundred localities, and these have since been analyzed by Mr. H. Leverin, of the Mines Branch. Note was made of quarrying possibilities at the various outcrops, and of transportation facilities. Working and abandoned quarries were also visited and sampled.

The sections of the province covered were as follows: from Bryson to Quyon; Hull and vicinity; the Gatineau valley, from Wakefield to Aylwin; Buckingham and vicinity; Argenteuil county; Ste. Thérèse and vicinity; Montreal and vicinity; and that portion of the province lying south of a line drawn through Valleyfield, Beloeil, St. Hyacinthe, Drummondville, and D'Israeli. Within these areas there are a number of localities which will be visited and examined later.

Mr. J. A. Fournier, a student at Queen's University, was field assistant, and fulfilled his duties well.

The following is a brief description of the limestones in those parts of the province visited, and analyses are quoted of samples, both from the more important occurrences, and also from those sections in which only impure material was found to exist.

BRYSON—QUYON.

Throughout the townships of Litchfield, Clarendon, and Bristol, there are numerous exposures of crystalline limestone. In the neighbourhood of Bryson and Portage du Fort the rock appears to be much freer from impurities than elsewhere.

At Bryson, Robert B. Carswell owns and operates a quarry and lime-kiln. There are two small quarry openings very close to one another. The western one furnishes the limestone for burning, which is fairly coarsely crystalline and is banded with dark streaks of impurities, principally graphite with some yellowish granules. In the eastern pit the stone is somewhat coarser in texture and is almost free from the graphite banding. This stone is used for building purposes.

Sample 4 is from the western pit, and 5, which is seen to be a true dolomite, is from the eastern pit. Both are of good grade:—

—	4.	5.
Insoluble mineral matter	1·34	2·08
Oxide of iron—all expressed as ferric oxide	0·36	0·07
Alumina	1·44	0·32
Calcium carbonate[1]	75·89	52·76
Magnesium carbonate[2]	21·21	44·96
Graphite	0·30	.....
[1] Equivalent to lime	42·50	29·55
[2] Equivalent to magnesia	10·15	21·51

At Portage du Fort, a large marble quarry has been opened by the Pontiac Marble and Lime Co., Ltd. The workings are to the north of the town, beside the right of way of the Canadian Northern railway which is under construction.

The stone is coarse grained, and varies from a pure white to white with yellow patches and veinlets. The waste rock and spalls should be of value as a source of dolomite for wood-pulp making. The following analysis is from a general sample taken of all the exposed beds:—

——	3.
Insoluble mineral matter	0·15
Oxide of iron—all expressed as ferric oxide	0·22
Alumina	0·06
Calcium carbonate[1]	57·14
Magnesium carbonate[2]	43·12
[1] Equivalent to lime	32·00
[2] Equivalent to magnesia	20·63

Along the Ottawa river at Portage du Fort, and on the island immediately opposite, there are numerous exposures of similar coarse grained dolomitic limestone.

In the eastern portion of the township of Clarendon the crystalline limestones, which outcrop frequently, are much less dolomitic, and are dirtier in appearance, containing almost 1 per cent of graphite as well as small quantities of mica, tourmaline, and tremolite. The average of several analyses of these limestones shows 7·3 per cent of magnesium carbonate, and 90·0 per cent of calcium carbonate.

Along the Canadian Northern railway new roadway, crystalline limestone has been exposed at a number of points in Bristol township; the stone being similar to that in the eastern portion of Clarendon.

Two exposures of what is probably Beekmantown limestone were observed, one at Quyon and the other at Portage du Fort. While suitable for rough building purposes, they are high in insoluble matter, iron and alumina, and would produce a very poor grade of lime.

HULL.

At Hull, Trenton limestone has been extensively quarried for building stone, macadam, lime-burning, and cement-making. A number of the beds produce a very high grade of building stone.

The stone is brownish in colour, and varies from very fine grained to fairly coarse. It produces a good grade of high calcium lime, when burned. Two analyses will serve to indicate the general composition:—

——	10.	11.
Insoluble mineral matter	3·24	0·84
Oxide of iron—all expressed as ferric oxide	0·21	0·21
Alumina	0·39	0·25
Calcium carbonate[1]	93·84	97·14
Magnesium carbonate[2]	1·31	1·48
[1] Equivalent to lime	52·55	54·40
[2] Equivalent to magnesia	0·63	0·71

GATINEAU VALLEY.

Throughout the Gatineau valley, crystalline limestones are found in many places, frequently extending in long bands for many miles. They are, as a rule, very coarse grained, and contain a noticeable quantity of impurities, such as mica, graphite, apatite, tourmaline, serpentine, chondrodite, and pyrite, and possess, consquently a dirty appearance.

Due to the rough nature of the country, there are numerous hills and knolls into which quarries could be easily developed; but this same roughness means hilly roads and expensive haulage charges, so that possible quarry locations are confined to a narrow strip, close to the railroad.

The following analyses are of samples from the best exposures of limestone visited:—

—	12.	13.	14.	15.	16.	17.
Insoluble mineral matter	1·00	3·39	2·00	3·80	1·42	1·44
Oxide of iron all expressed as ferric oxide	0·14	0·28	0·30	0·24	0·14	0·14
Alumina.......	0·06	0·06	0·06	0·02	0·04	0·06
Calcium carbonate[1]........	85·00	88·48	85·89	93·57	95·09	92·59
Magnesium carbonate[2]...	13·66	6·56	12·24	1·98	2·38	6·45
Carbon (graphite)..........	0·42	1·67	....	....	0·42	....
[1] Equivalent to lime................ ..	47·60	49·55	48·10	52·40	53·25	51·85
[2] Equivalent to magnesia.	6·54	3·14	5·86	0·95	1·14	3·09

12. From small quarry at Ste. Cecile de Masham.
13. From rock cut on railroad at Farrelton.
14. From foot of Paugen falls, west side of Gatineau river.
15. From lot 39, range VIII, Aylwin township.
16. From lot 16, range III, Aylwin township.
17. From farm of Thos. McCombley, lots 6 and 7, range VI, Aylwin township. A small quantity of lime is burned here for local use.

BUCKINGHAM.

The crystalline limestones seen in the district around Buckingham, are all very impure, and are unsuitable for lime-burning purposes.

ARGENTEUIL COUNTY.

The rocks of the major part of the county of Argenteuil are of Laurentian age. Crystalline limestones are fairly abundant, extending in long narrow belts in a generally norht and south direction. The southeastern portion of the county is overlain by more recent rocks, and, for the greater part, has a continuous covering of soil. Limestones of Calciferous age are to be seen in a few places.

In the township of Grenville, the crystalline limestones vary greatly in character and purity. On lot 15, range IX, and lot 18, range XI, quarries have been opened in deposits of a super-magnesia dolomite or calcareous magnesite. On lot 15, range IX, a calcining kiln about 40 feet high, and 7 feet internal diameter, has been built by the Canadian Magnesite Co., Ltd.,—owners of both properties. Most of the haulage is done in the winter, owing to the poor summer roads.

The following analyses are of general samples, "21" being from lot 15, range IX, and "X" from lot 18, range XI:—

——	21.	X.
Insoluble mineral matter	2·20	[1]11·67
Oxide of iron—all expressed as ferric oxide	0·13	0·17
Alumina	0·03	Not det.
Magnesia	39·12	42·00
Lime	8·80	7·40
Carbon dioxide	[2]49·72	47·56

[1]Silica. [2]By difference.

The crystalline limestones of this county vary greatly in content of magnesia, and range from less than one per cent, to very highly magnesian. As a rule they contain noticeable amounts of graphite, chondrodite, and other impurities.

Immediately south of Lachute, a fine grained, hard, bluish limestone is being quarried for road metal on the farm of George Fraser. It is probably of Calciferous age. The following is the analysis of a sample taken at this quarry:—

——	26.
Insoluble mineral matter	18·80
Oxide of iron—all expressed as ferric oxide	0·55
Alumina	1·45
Calcium carbonate[1]	45·44
Magnesium carbonate[2]	33·15
[1]Equivalent to lime	25·45
[2]Equivalent to magnesia	15·86

There are many exposures of limestone along the Ottawa river, between Carillon and Grenville. In some places, the beds are of fair thickness, but in others are thin, and full of shale partings. The two following analyses will serve to indicate the composition of the limestone exposed in this part of the county:—

——	28.	29.
Insoluble mineral matter	3·70	6·90
Oxide of iron—all expressed as ferric oxide	0·55	0·70
Alumina	0·25	0·90
Calcium carbonate[1]	91·96	82·59
Magnesium carbonate[2]	2·13	7·10
[2]Equivalent to lime	51·50	46·25
[1]Equivalent to magnesia	1·02	3·40

Sample 28.—From an old quarry near the head of Carillon canal. One bed is 18 inches thick.

Sample 29.—From cliff, on bank of Ottawa river, between Cushing and Stonefield. Here the beds are thin with shale partings.

STE. THÉRÈSE.

Three miles north of Ste. Thérèse, there is a quarry, and an old fashioned lime-kiln, owned by Placide Sauche. Some of the stone from this quarry has been used for building purposes. It is of good texture, and occurs in beds of workable thickness. It probably belongs to Chazy age. The following analysis is from a sample taken in this quarry:—

—	30.
Insoluble mineral matter	1·90
Oxide of iron—all expressed as ferric oxide	0·70
Alumina	0·16
Calcium carbonate[1]	94·64
Magnesium carbonate[2]	2·38
[1] Equivalent to lime	53·00
[2] Equivalent to magnesia	1·14

Within the town of Ste. Thérèse, and to the south of the town, are two quarries from which limestone is being taken for road metal. The rock is close-grained, hard, and appears to be well suited to the purpose. The two following analyses are of samples taken from these quarries:—

—	31.	32.
Insoluble mineral matter	13·84	6·70
Iron oxide—all expressed as ferric oxide	1·21	1·13
Alumina	0·21	2·40
Calcium carbonate[1]	49·91	61·16
Magnesium carbonate[2]	34·36	25·91
[1] Equivalent to lime	27·95	34·25
[2] Equivalent to magnesia	16·44	12·40

Sample 31 from quarry, in Ste. Thérèse, owned by J. Fred Pare.
Sample 32 from quarry one-half mile south of Ste. Thérèse station.

MONTREAL AND VICINITY.

On the island of Montreal there are numerous limestone quarries, large and small. Some of these were visited during the past season, but much work remains to be done during the field season of 1915. The following analyses are given as an indication of the composition of the stone from the various districts:—

—	38.	39.	41.	43.
Insoluble mineral matter	5·04	14·00	1·64	1·86
Iron oxide—all expressed as ferric oxide	0·43	0·40	0·93	0·50
Alumina	0·97	0·10	0·17	0·34
Calcium carbonate[1]	91·96	79·91	88·39	90·44
Magnesium carbonate[2]	1·92	2·75	8·94	2·31
[1] Equivalent to lime	51·50	44·75	49·50	50·65
[2] Equivalent to magnesia	0·92	1·32	4·28	1·11

Sample 38 from quarry operated by Norman M. McLeod at Point Clair. General sample of face about 40 feet high.

Sample 39 from quarry of Canada Cement Co., Ltd., at Pointe aux Trembles. General sample of face about 30 feet high.

Sample 41 from St. Denis quarry, in the Villeray group of quarries.

Sample 43 from one of the quarries on the property of M. S. Jarry, Mile End group.

The first, second, and fourth of these quarries are in Trenton limestone and the third in Chazy limestone.

On Ile Jésus, which lies to the north of Montreal island, there are a number of quarries situated at St. Vincent de Paul, St. Martin, Cap St. Martin, Village Belanger, and St. Francois de Salles. The field work on these quarries is not yet complete:—

——	34.	35.	36.	37.
Insoluble mineral matter	2·30	1·44	3·76	1·30
Iron oxide—all expressed as ferric oxide	0·70	0·64	0·71	0·50
Alumina	1·40	0·12	0·33	0·14
Calcium carbonate[1]	93·75	95·93	91·60	95·98
Magnesium carbonate[2]	1·46	1·58	2·17	1·58
[1] Equivalent to lime	52·50	53·50	51·30	53·75
[2] Equivalent to magnesia	0·70	0·76	1·04	0·76

Sample 34 from quarry of N. Brunet, near St. Vincent de Paul.

Sample 35 from quarry of Joseph Monette, Village Belanger.

Sample 36 from Paquette and Gauthier's quarry, Cap St. Martin.

Sample 37 from quarry of Théodule Saumure, Cap St. Martin, one-half mile east of sample 36.

VALLEYFIELD AND HUNTINGDON.

That portion of the province of Quebec lying between the International Boundary and the St. Lawrence river, and west of St. Timothe, St. Etienne, and Ormstown, is underlain, almost entirely, by Calciferous beds.

The surface soil or clay is very thin in many places, and outcrops of rock are frequently met with. At Valleyfield, two quarries, opened in highly siliceous beds, are being operated at present. The product of these quarries consists of building and curbstones and broken stone for concrete and road metal. The stone is very hard, and breaks with a subconchoidal fracture.

A sample taken from one of these quarries contained 46·5 per cent of insoluble mineral matter, 15·5 per cent lime, and 9·64 per cent magnesia.

About 7 miles southeast of Valleyfield, near St. Louis de Gonzague, there are two quarries from which stone is being taken for road metal. The stone is similar to that being quarried at Valleyfield, but is less siliceous. A sample taken from the quarry of Théoret and Leduc contained 32·0 per cent insoluble mineral matter, 20·70 per cent lime, and 13·24 per cent magnesia.

In the township of Godmanchester, two quarries, from which limestone was being taken for road metal and concrete, were visited. That owned by O'Connor Brothers, and located on lot No. 416, about 2 miles west of Huntingdon, shows about 11 feet of strata.

One mile west of the above, Ross, Church, and Company have recently opened a quarry for road metal. About 8 feet of hard, tough, fine grained, grey limestone are exposed:—

——	59A.	59B.	60.
Insoluble mineral matter	7·64	3·40	15·30
Iron oxide—all expressed as ferric oxide	0·93	0·86	0·86
Alumina	1·33	0·60	0·38
Calcium carbonate[1]	57·85	52·23	45·53
Magnesium carbonate[2]	31·22	41·80	36·62
Phosphorus	Not det.	Not det.	0·008
Sulphur	Not det.	Not det.	0·458
[1] Equivalent to lime	32·40	29·25	25·50
[2] Equivalent to magnesia	14·92	20·00	17·52

Sample 59A represents the top 6 feet of O'Connor Brothers' quarry.

Sample 59B represents the lower 5 feet of O'Connor Brothers' quarry.

Sample 60 was taken in the quarry of Ross, Church, and Company.

Near Caughnawaga, there are a number of quarries from which much limestone has been taken for building stone, and lime-burning, also, for rubble and concrete. At the time of my visit, only one quarry was in operation. It was the old "Indian Quarry," situated about a mile to the west of the village. Here, G. H. Leahy, of Montreal, was removing spalls and waste rock for rubble work. A sample taken down the face of the quarry gave the following analysis:—

——	55.
Insoluble mineral matter	4·66
Iron oxide—all expressed as ferric oxide	1·43
Alumina	0·57
Calcium carbonate[1]	89·10
Magnesium carbonate[2]	3·97
[1] Equivalent to lime	49·90
[2] Equivalent to magnesia	1·90

RICHELIEU VALLEY, SOUTH.

To the west of the Richelieu river, and south of St. Johns, there are numerous exposures of limestone suitable for lime-burning, building purposes, and for road metal.

Between St. Johns and L'Acadie, two quarries were visited. Lord and Herbert's quarry, situated about 2 miles due west of St. Johns, is at present closed. One mile farther west is the quarry of David Brault. This quarry is producing crushed stone only, as, also, did that of Lord and Herbert. The following analysis is of an average sample from Brault's quarry: —

——	45.
Insoluble mineral matter	10·26
Iron oxide—all expressed as ferric oxide	0·63
Alumina	0·17
Calcium carbonate[1]	84·64
Magnesium carbonate[2]	2·90
[1] Equivalent to lime	47·40
[2] Equivalent to magnesia	1·39

Near Grande Ligne, there is a large and well equipped quarry—at present idle—owned by the Otis Quarries, Ltd. It is situated about a mile and a half north of the village, and is connected with the Grnad Trunk railway by a spur about one-half mile in length. The limestone there is found is fairly massive beds, some being 18 to 24 inches thick, and is of good colour and texture. At the time of my visit, there was much water in the pit, but a sample was secured representative of the upper ten feet of the beds; this yielded:—

——	48.
Insoluble mineral matter	2·72
Iron oxide—all expressed as ferric oxide	0·71
Alumina	0·17
Calcium carbonate[1]	85·35
Magnesium carbonate[2]	10·24
[1] Equivalent to lime	47·80
[2] Equivalent to magnesia	4·90

About 6 miles south of Grande Ligne, and 1 mile northwest of Stottsville, there is an old quarry from which stone was taken many years ago, for lime-burning and building purposes.

The following analysis is of a sample taken in this pit:—

——	51.
Insoluble mineral matter	2·06
Iron oxide—all expressed as ferric oxide	0·14
Alumina	0·06
Calcium carbonate[1]	90·44
Magnesium carbonate[2]	5·22
[1] Equivalent to lime	50·65
[2] Equivalent to magnesia	2·50

About 2½ miles west of Lacolle village, on range IV of Lacolle township, there is an extensive exposure of a close grained, bluish-grey limestone, on the property of O. Duchêne. This stone occurs in beds from one to three feet thick, and should prove suitable for building stone or road metal. A partial analysis showed:—

Insoluble mineral matter	34·30
Lime	27·75
Magnesia	6·56

West of Napierville, two old abandoned quarries were visited. One is on the property of Arthur Fortin, one mile west of Napierville, and the other one mile farther west, near Douglas Corner, on the property of Hormidas Bechard. Some years ago lime was burned at both pits:—

——	52.	53.
Insoluble mineral matter	3·76	3·30
Iron oxide—all expressed as ferric oxide	0·14	0·50
Alumina	0·06	0·06
Calcium carbonate[1]	91·60	72·19
Magnesium carbonate[2]	3·44	24·45
[1] Equivalent to lime	51·30	40·42
[2] Equivalent to magnesia	1·65	11·70

Sample 52 was taken from property of A. Fortin.

Sample 53 was taken from property of H. Bechard.

On lot 6, Côte St. Marc, Laprairie county, a little over 2 miles northwest of St. Jacques, there is an old quarry from which building stone has been taken. There was much water in the pit at the time of my visit, but the beds appeared to be of considerable thickness, and to consist of a good grade of building stone. The following analysis is of a sample taken from the upper beds:—

——	54.
Insoluble mineral matter	1·40
Iron oxide—all expressed as ferric oxide	0·40
Alumina	0·04
Calcium carbonate[1]	90·27
Magnesium carbonate[2]	7·27
[1] Equivalent to lime	50·55
[2] Equivalent to magnesia	3·48

MISSISQUOI COUNTY.

From an economic standpoint, the limestones in this county may be placed into three groups.

The first group of samples, including numbers 69, 71, 72, 74A, 74B, and 75, are all very low in insoluble mineral matter and other impurities. These samples were taken over a rather narrow strip of country extending from the southwest corner of St. Armand township, on the shore of Missisquoi bay, to a point about 1 mile southwest of the town of Bedford. The stone is light bluish-grey for the most part, and is extremely fine grained. At Philipsburg, the rock is variegated, and yields a beautifully marked marble. The whole of the above area is in close proximity to railroads and lies within 55 miles of Montreal. It should, therefore, be classed as one of the most important limestone localities within the province.

At Philipsburg, the Missisquoi-Lautz Corporation, Ltd., operate a modern limekiln in connexion with their large quarry and polishing works:—

—	69.	71.	72.	74A.	74B.	75.
Insoluble mineral matter	1·50	0·40	0·28	1·14	3·94	1·60
Iron oxide all expressed as ferric oxide.	Trace.	0·07	Trace.	0·14	0·28	0·24
Alumina	0·10	0·04	0·04	0·06	0·18	0·02
Calcium carbonate[1]	95·80	98·75	98·93	96·25	94·91	96·16
Magnesium carbonate[2]	1·90	1·21	1·07	1·44	0·98	1·75
Phosphorus	Not det.	Not det.	Not det.	Not det.	Not det.	0·041
Sulphur	Not det.	Not det.	Not det.	Not det.	Not det.	0·016
[1]Equivalent to lime	53·65	55·30	55·40	53·90	53·15	53·85
[2]Equivalent to magnesia	0·91	0·58	0·51	0·69	0·47	0·86

Sample 69 was taken on the farm of D. J. Pells, lot 2, range VII, Stanbridge township.

Sample 71 was taken on lot 6, range VII, Stanbridge township.

Sample 72 was taken on the farm of E. H. Morgan, lot 2, range IX, Stanbridge township.

Samples 74A and 74B were taken from the spalls at the marble quarry of the Missisquoi-Lautz Corporation, Ltd., at Philipsburg. Sample 74A represents the white and light coloured spalls, and 74B the darker and less pure spalls.

Sample 75 was taken on lot 21, West Parish of St. Armand, owned by M. McNamara, of Bedford.

The accompanying map shows the localities from which the samples were taken.

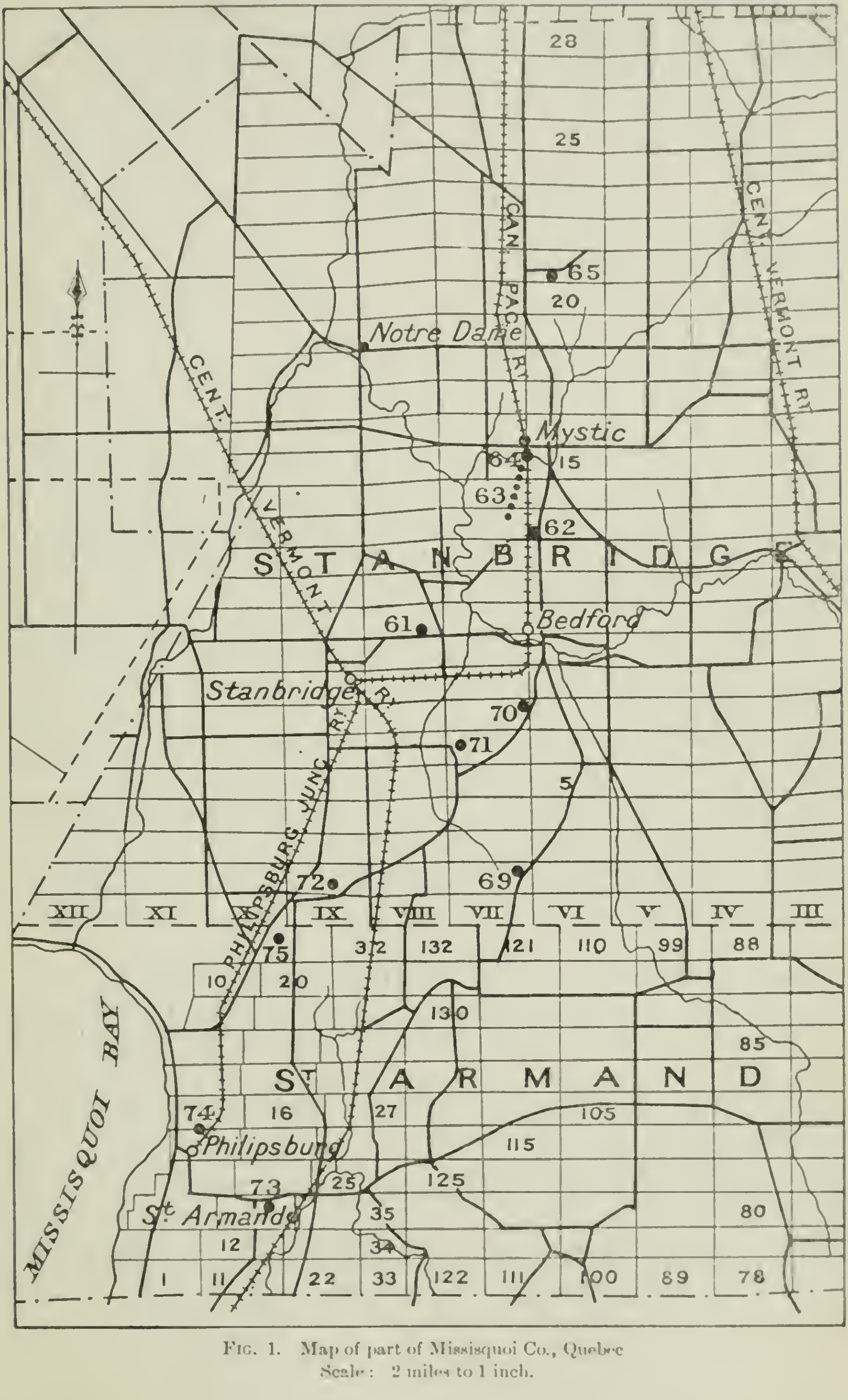

FIG. 1. Map of part of Missisquoi Co., Quebec
Scale: 2 miles to 1 inch.

The second group of samples, including numbers 61, 63, 64, and 65, were taken along a ridge which extends north and south for a number of miles through Mystic, and about one mile to the east of Bedford. The limestone is a brecciated, light grey to bluish-grey, fine grained stone, much interveined in places with calcite. Sample 69, of the first group, while much purer, is also a brecciated limestone:—

—	61.	63.	64.	65.
Insoluble mineral matter	5·46	5·30	5·50	5·04
Iron oxide —all expressed as ferric oxide	0·27	0·43	0·28	0·45
Alumina	0·13	0·07	0·08	0·11
Calcium carbonate[1]	90·53	90·80	91·78	91·43
Magnesium carbonate[2]	1·81	1·75	1·62	1·56
[1]Equivalent to lime	50·70	50·85	51·40	51·20
[2]Equivalent to magnesia	0·87	0·84	0·78	0·75

Sample 61 was taken about one mile east of Stanbridge station, on the road to Bedford.

Sample 63 consisted of material taken from various points along the ridge, over a distance of half a mile, on lots 13, 14, and 15, range VII, Stanbridge township.

Sample 64 was taken in an old quarry, owned by A. S. Walbridge, of Mystic, on lot 15, range VII, Stanbridge.

Sample 65 was taken on lot 21, range VI, Stanbridge.

The third group of samples taken in Missisquoi county consists of much less pure material. The samples were taken to the east of the two foregoing districts. The stone here is uniformly darker in colour than in the former areas, and is made up of alternating layers of very thin shale and limestone. It is considerably higher in magnesia, and although in some places the percentage of shale present is small, the rock is, for the most part, of little or no commercial value. Three samples, numbers 62, 70, and 73 were taken to indicate the nature of the stone.

Sample 62, taken on lot 13, range VI, Stanbridge township, contained 43·02 per cent insoluble mineral matter, 16·55 per cent lime, and 9·98 per cent magnesia.

Sample 70, taken on lot 7, range VI Stanbridge township, contained 30·54 per cent insoluble mineral matter, 39·50 per cent lime, and 1·73 per cent magnesia. On this same lot, but farther to the west, outcrops of a better grade of limestone were noticed.

Sample 73 was taken on lot 13, West Parish St. Armand township:—

—	73.
Insoluble mineral matter	8·82
Iron oxide—all expressed as ferric oxide	0·53
Alumina	0·29
Calcium carbonate[1]	80·35
Magnesium carbonate[2]	6·16
[1]Equivalent to lime	45·00
[2]Equivalent to magnesia	2·95

ROUVILLE COUNTY.

In the county of Rouville, two limestone exposures were sampled.

Two samples were taken from old quarries on the farm of H. Berard, on the south side of the Casimir road, one-half mile southeast of the main road running north from Farnham. Sample 66 is an average sample taken in the southernmost quarry, and sample 67 represents the material of the upper beds exposed in the north quarry. The lower beds in the quarry are similar to those of the south quarry. The limestone of the south quarry is very dark in colour. Calcite veins are abundant in both quarries. The upper stone of the north quarry is thinly bedded and hard:—

—	66.	67.
Insoluble mineral matter	13·00	10·16
Iron oxide—all expressed as ferric oxide	0·24	Trace.
Alumina	0·06	0·10
Calcium carbonate[1]	83·03	87·05
Magnesium carbonate[2]	2·77	2·40
[1]Equivalent to lime	46·50	48·75
[2]Equivalent to magnesia	1·33	1·15

The other locality sampled in Rouville county was on the farm of Antoine Menard, on the north side of the Papineau road. The beds are very thin and are interveined with calcite in many places. The dip is about 75 degrees to the west. An analysis of stone from this locality follows:—

—	78.
Insoluble mineral matter	10·44
Iron oxide—all expressed as ferric oxide	0·24
Alumina	0·10
Calcium carbonate[1]	86·07
Magnesium carbonate[2]	1·81
[1]Equivalent to lime	48·20
[2]Equivalent to magnesia	0·87

BAGOT COUNTY.

At La Carrière, situated about 4 miles southeast of St. Hyacinthe, there are a number of small quarries asd lime-kilns. These pits produce building stone, as well as stone for lime-burning.

The three following quarries were visited. On the north side of the road, a small pit is worked by Alfred Corneau, from which he takes stone for a small lime-kiln. Sample 76 was taken here.

Joseph Lapointe's quarry to the south of the road, produces building stone, and supplies stone to Benoit et Fils, for lime-burning. Sample 77 was taken from this quarry.

Adolph Barrow's building stone quarry is situated a short distance to the west of the preceding one. The stone is similar to that from the pit owned by Alfred Corneau.

Benoit et Fils operate two lime kilns at St. Dominique, a short distance southeast of LaCarriere. They purchase all the limestone used.

—	76.	77.
Insoluble mineral matter	1·84	1·00
Iron oxide—all expressed as ferric oxide	0·14	0·14
Alumina	0·08	0·02
Calcium carbonate[1]	96·07	96·43
Magnesium carbonate[2]	0·69	1·67
[1]Equivalent to lime	53·80	54·00
[2]Equivalent to magnesia	0·33	0·80

In the township of Upton, Bagot county, there are a number of exposures of fairly good limestones. Two outcrops were sampled.

About 2½ miles north of Upton, on lot 51, range XXI, there is a small pit by the road where prospecting work has been done on a showing of copper ore. The country rock is limestone, which is well exposed over a considerable area to the north of the pit. Sample 93 was taken from the limestone exposed in the prospect hole. Owing to the weathered condition of the stone and the difficulties of sampling, it was impossible to get truly representative material.

Sample 94 was taken on lot 49, range XX. Here, also, some prospecting has been done for copper.

The limestone forms a ridge about 20 feet high, and covers two acres or more.

Other ridges or "hogs-backs," are to be seen on the opposite side of the road.

—	93.	94.
Insoluble mineral matter	6·36	4·40
Iron oxide—all expressed as ferric oxide	0·59	0·71
Alumina	0·13	0·45
Calcium carbonate[1]	90·09	83·12
Magnesium carbonate[2]	1·38	10·07
[1]Equivalent to lime	50·45	46·55
[2]Equivalent to magnesia	0·66	4·82

On lot 34, range V, Acton township, Bagot county, there is a large exposure of light grey, fine grained limestone. It is owned by Eugene Leclerc, and in it are some small pits from which stone was taken for lime-burning a number of years ago. Sample 95 consists of stone taken in several of these pits. This property is situated about one mile north of Actonvale.

A specially selected sample, number 96, was taken in the old Actonvale copper mine, on lots 31 and 32, range III, Acton township, a short distance southeast of Actonvale. In taking the sample, an effort was made to avoid such pieces of the limestone as contained noticeable quantities of copper or other sulphides, the object being to obtain a sample representative of what would be waste rock from copper mining. Upon the large waste dumps about the mine are large quantities of broken limestone:—

—	95.	96.
Insoluble mineral matter	5·06	5·06
Iron oxide—all expressed as ferric oxide	0·43	0·37
Alumina	0·57	0·39
Calcium carbonate[1]	84·91	83·57
Magnesium carbonate[2]	8·86	10·16
[1]Equivalent to lime	47·55	46·80
[2]Equivalent to magnesia	4·24	4·86

DRUMMOND COUNTY.

Only one limestone quarry was visited in this county.

Sample 78 was taken in a small quarry on lot 14, range X, West Wickham township. This is owned by E. Lupien, who burns lime in a small kiln. The stone is much interveined with calcite, and contains some copper pyrites:—

—	78.
Insoluble mineral matter	6·08
Iron oxide—all expressed as ferric oxide	0·53
Alumina	1·37
Calcium carbonate[1]	76·25
Magnesium carbonate[2]	10·84
[1]Equivalent to lime	42·70
[2]Equivalent to magnesia	5·16

Along the St. Francis river, near Drummondville, there are a number of exposures of impure limestone. A sample taken 4 miles up-stream from Drummondville contained about 30 per cent of insoluble mineral matter.

DANVILLE AND VICINITY.

All the limestones seen in this neighbourhood were impure, with thin interbedding of slate, and often much interlaced with veinlets of quartz and calcite.

The three following analyses will serve to illustrate the composition of the limestones of the district:—

—	110.	111.	112.
Insoluble mineral matter	17·41	9·58	17·20
Iron oxide—all expressed as ferric oxide	1·10	0·85	1·07
Alumina	0·41	0·11	0·08
Calcium carbonate[1]	78·39	87·14	77·59
Magnesium carbonate[2]	1·52	1·90	2·65
[1]Equivalent to lime	43·90	48·80	43·45
[2]Equivalent to magnesia	0·73	0·91	1·27

Sample 110 was taken on lot 23, range I, Warwick township, Arthabaska county.

Sample 111 was taken on lot 18, range I, Shipton township, Richmond county. This sample was somewhat weathered, and is therefore probably slightly higher in insoluble matter than it should be. It was difficult to obtain a sample, as the old pits were all filled in with soil. At one time lime was burned here for local use. Sample 112 was taken on lot 17, range VII, Tingwick township, Arthabaska county. At one time lime was burned here for local use.

STUKELY TOWNSHIP.

The Dominion Marble Co., Ltd., is quarrying marble on lot 8, range II, South Stukely, Shefford county. The stone is of fine texture and handsomely marked, the various beds supplying marble of different combinations of colours.

The two following analyses are of samples of spalls and waste rock taken at this quarry. Sample 81A is of the white stone, and 81B of the coloured stone:—

——	81A.	81B.
Insoluble mineral matter	5·10	5·56
Iron oxide—all expressed as ferric oxide	1·86	0·56
Alumina	1·24	0·20
Calcium carbonate[1]	62·50	83·75
Magnesium carbonate[2]	28·51	9·94
[1]Equivalent to lime	35·00	46·90
[2]Equivalent to magnesia	13·64	4·76

This quarry was originally opened to supply stone for lime-burning. For some time no lime has been burned here.

In the village of South Stukely, near the station, quarries have been worked in the past, but are now idle.

On lot 13, range VII, North Stukely, Delphio Bauregard operates a quarry and lime-kiln. Sample 82 was taken in this quarry:—

——	82.
Insoluble mineral matter	1·20
Iron oxide—all expressed as ferric oxide	0·20
Alumina	Trace.
Calcium carbonate[1]	95·18
Magnesium carbonate[2]	3·05
[1] Equivalent to lime	53·30
[2] Equivalent to magnesia	1·46

KNOWLTON AND VICINITY.

Two old abandoned quarries were visited near Knowlton. The stone in both quarries is very dirty in appearance, and much fractured. Sample 80 was taken in the quarry on the farm of J. C. Patterson, lot 10, range XI, Brome township, and sample 83 at the quarry on lot 16, range XI, Brome township. Lime was burned at both of these localities many years ago, and is said to have been strong though dark in colour:—

—	80	83.
Insoluble mineral matter	9·88	7.22
Iron oxide—all expressed as ferric oxide	3·86	1·00
Alumina	0·70	0·04
Calcium carbonate[1]	49·10	83·48
Magnesium carbonate[2]	36·07	4·18
[1] Equivalent to lime	27·05	46·75
[2] Equivalent to magnesia	17·26	2·00

LAKE MEMPHREMAGOG.

On the east side of Lake Memphremagog, there are innumerable exposures of slaty black limestones. Lime has been burned from time to time at various points near the shore, but of late years no use has been made of the stone. At Magoon point, a purer grade of limestone is reported. It was impossible to visit this during the past summer. Samples will be obtained later.

Near Sargents bay, on the west side of the lake, there are a few exposures of limestone which have been quarried in the past for the production of stone for lime-burning.

The following analyses are of samples taken in this district:—

—	84.	85.	86.	88.	89.
Insoluble mineral matter	10·14	13·44	6·60	11·44	9·78
Iron oxide—all expressed as ferric oxide	0·79	0·35	0·57	0·50	0·64
Alumina	4·15	0·26	0·11	0·38	0·52
Calcium carbonate[1]	50·09	83·30	90·35	81·78	84·28
Magnesium carbonate[2]	35·70	2·29	1·52	2·54	2·59
[1] Equivalent to lime	28·05	46·65	50·60	45·80	47·30
[2] Equivalent to magnesia	17·08	1·10	0·73	1·22	1·24

Sample 84 was taken on lot 12, range XIV, Magog township, Stanstead county.

Sample 85 was taken in an old quarry, on lot 27, range II, Stanstead township, Stanstead county.

Sample 86 was taken along the shore of the lake, near the site of an old lime-kiln, on lots 20 and 21, range I, Stanstead township, Stanstead county.

Sample 88 was taken in an old pit on lot 28, range X, Bolton township, Brome county.

Sample 89 was taken on the farm of S. A. Jones, lot 24 (?), range X, Potton township, Brome county.

SOUTHEASTERN COUNTIES.

In Stanstead county, east of Lake Memphremagog, and in Sherbrooke and Compton counties, the limestones encountered are all very highly arenaceous, and almost black in colour.

The following partial analyses are quoted merely to indicate the type of rock which occurs throughout this section:—

—	87.	91.	92.	97.
Insoluble mineral matter	37·28	47·12	50·00	54·16
Lime	31·00	25·30	24·55	20·86
Magnesia	2·40	2·86	1·53	2·70

Sample 87 was taken on lot 11, range V, Stanstead township, Stanstead county.

Sample 91, was taken on lot 7, range V, Ascot township, Sherbrooke county.

Sample 92 was taken on lot 6, range IV, Hatley township, Stanstead county.

Sample 97 was taken in the bed of a river on lot 5, range V, Barnston township, Stanstead county.

ALONG QUEBEC CENTRAL RAILWAY (SHERBROOKE TO D'ISRAELI).

Search was made for limestone for several miles on both sides of the Quebec Central railway. Most of the limestones within this area are very impure, and thin bedded. At Bishop Crossing, a highly arenaceous limestone is quarried for flagstone. The stone splits readily along the bedding plains, producing an even and very true surface. Flags are made up to 12 feet by 5 feet, and from 2 to 5 inches thick. Along the ridge which runs from Lime Ridge to Aylmer lake, there are occasional exposures of limestone of much better grade, several of which have been worked.

At Lime Ridge, in Dudswell township, Wolfe county, the Dominion Lime Co., Limited, operates a large quarry, which supplies stone to eleven lime-kilns. Five of these are modern gas-fired kilns, and the balance are fired with wood.

The stone is compact, and for the greater part, free from slate.

This is the only working quarry in the district:—

—	90.	98.	99.	100.	101.	102.	103.	104.	105.	106.	107.	108.	109.
Insoluble mineral matter	66·94	38·82	2·00	1·80	0·60	38·20	20·00	5·92	21·14	14·74	51·82	9·88	20·34
Iron oxide, all expressed as ferric oxide	....	.....	0·21	0·21	0·10	.....	......	0·35	.....	1·28	......	0·45	......
Alumina	.....	......	0·09	0·11	0·02	...	....	0·16	......	0·82	......	0·15	....
Calcium carbonate[1]	......	.....	95·71	96·87	98·75	......	......	91·52	......	52·23	......	87·50	......
Magnesium carbonate[2]	......	.....	1·19	1·34	0·85	......	......	1·81	......	29·26	.....	1·60	......
	......	.....	99·20	100·33	100·32	.....	.....	99·76	....	98·33	......	99·58	......
[1] Equivalent to lime	11·90	29·10	53·60	54·25	55·30	32·00	31·15	51·25	40·10	29·25	17·20	49·00	41·35
[2] Equivalent to magnesia	1·92	3·78	0·57	0·64	0·41	1·56	11·66	0·87	2·29	14·00	4·36	0·77	2·18

Sample 90 was taken on lot 13, range VII, Stoke township, Richmond county, near Stoke Centre.

Sample 98 was taken by the roadside 2 miles southwest of Weedon in Weedon township, Wolfe county.

Sample 99 was taken in an old marble quarry on lot 21, range VII, Dudswell township, Wolfe county. The blocks of stone in the quarry show rather bad weathering.

Samples 100 and 101 were taken in the quarry of the Dominion Lime Co., Ltd. The former represents the material of the northeast working face of the pit, and the latter that of the southeast working face.

Sample 102 was taken from the pile of waste rock of Wm. Bentley's flagstone quarry, on lot 15, range V, Dudswell township.

Sample 103 was taken on lot 17, range III, Weedon township, along the road which leads from Weedon station to Weedon Mines.

Sample 104 was taken in a small quarry, which is at present idle, on lot 21, range VII, Weedon township. The stone which is somewhat shattered and interveined with calcite, was, a few years ago, used for lime-burning. There is some pyrite visible in this limestone.

Sample 105 was taken on Long point, Aylmer lake, in Garthby township, Wolfe county. It represents an impure thin bedded limestone of no apparent value.

Sample 106 was taken from a knoll of brecciated fine grained limestone, somewhat over 100 feet long and 60 feet in width, on lot 22, range V, Stratford township, Wolfe county.

Sample 107 represents a slaty limestone which occurs on a point in Lake St. Francis, on lot 22, range III, Lambton township, Frontenac county.

Sample 108 was taken in an old quarry owned by Francois Briere, situated on lot 26, range VII, Weedon township. The limestone occurs in fairly massive beds, with thin slate partings. This stone was at one time burned for lime, and is said to have produced a strong hydraulic lime.

Sample 109 was taken on lot 3, range C, Garthby township, Wolfe county.

EXTENSION OF WORK.

This investigation of the limestones of Quebec will be continued during 1915.

II.

INVESTIGATION OF MISCELLANEOUS NON-METALLIC MINERALS.

Hugh S. de Schmid.

During the season of 1914, I visited a number of localities in the provinces of Ontario, New Brunswick, and Nova Scotia, at which non-metallic minerals are being worked, or have been worked within recent years. The visits were made for the purpose of obtaining first-hand information as to the extent of the operations hitherto carried out upon the deposits of the various minerals; to investigate the methods of working and treating the material produced; and to determine the future economic possibilities of the deposits: such information, if circumstances warrant it, to be published in a series of short, individual bulletins.

The minerals investigated include the following: barytes, manganese, infusorial earth, scheelite, talc, fluorspar, and actinolite. In addition to securing data on the foregoing, visits were made to all the fertilizer works in Eastern Canada, for the purpose of obtaining information as to the nature, capacity, etc., of the various plants; these details being required for inclusion in the report on phosphate, now nearing completion. The feldspar district north of Kingston, Ont., was also visited, in order to bring up to date the information already collected on this industry, and to take note of any new developments since the last visit paid to this section, in 1912. Certain other feldspar deposits in the more or less immediate vicinity of Ottawa were visited, these having been either only recently discovered or exploited.

Of the minerals mentioned above, (not including feldspar), the only ones that are being worked actively at the present time were found to be talc, infusorial earth, and barytes. Although the present output and importance of any of the minerals mentioned is comparatively small, and hardly justifies the preparation of an individual bulletin, nevertheless the data secured has proved of the greatest assistance in enabling the Mines Branch to supply the latest information regarding the different industries to the numerous interested parties, both at home and abroad, who have addressed inquiries since the outbreak of the war concerning the possibility of obtaining from this country certain minerals, the supply of which has been curtailed, or cut off by the war. Particularly was this the case with barytes and infusorial earth, which, from the number of inquiries received, would seem to be in great demand, the former by domestic and the latter by British consumers.

Brief mention of the actual status of the above-mentioned industries is made below.

ACTINOLITE.

Mining of this mineral has not been carried on for several years past, and in 1914, only a small shipment of ground mineral from stock was made. The actinolite deposits are situated in Elzevir township, Hastings county, and Kaladar township, Lennox county, Ontario, and are owned by the Actinolite Mining Company, of Bloomfield, N.J.

Actinolite, which is a green, fibrous mineral, is used as a cheap substitute for asbestos, for insulating boilers and steam pipes; also, when finely ground, in plaster. About 10 per cent of the mineral mined in Elzevir township is stated to be sufficiently fibrous to be employed in boiler covering.

BARYTES.

Barytes exists in large amount in the vicinity of Lake Ainslie, Cape Breton. This is the only section in Nova Scotia where the mineral has been found in large quantities, though small outcrops or float have been recorded at several points in the province; and mining has been conducted near Five Islands, Colchester county. In former years, comparatively large quantities of crude mineral were exported to the United States (1,700 tons in 1905). A smaller amount was shipped to grinding mills at Halifax, which supplied to domestic paint works.

Latterly, the export trade in crude mineral has dwindled, and very little mining has been done. Barytes, Ltd., who control the greater number of the Lake Ainslie deposits, have, during the past few years, been engaged in perfecting a refining process, whereby the small, but, nevertheless, significant amount of impurities in the ore can be eliminated. These impurities consist of calcium carbonate, manganese oxide, silica, and fluorite. Toward the end of 1914, the Company announced that the difficulties had been largely overcome, and that it was hoped shortly to place on the market a product in every way equal to the imported, refined barytes, which, hitherto, had been obtained chiefly from Germany. The Company have a mill and refining plant on the east side of Lake Ainslie, within a short distance of the Peter Campbell property, from which the greater part of the mineral mined in recent years has been taken.

From the Johnson mine, south of the Barytes Ltd., properties, Messrs. Brandram-Henderson, paint manufacturers, have, for a number of years past, taken out small quantities of barytes for use in their own works. The mineral was shipped to Halifax, and there ground at the Company's mill, on Northwest Arm.

The Lake Ainslie barytes occurs on well-defined veins, which attain a width of as much as 16 feet, and are found in zones along the lofty ridge which overlooks the east shore of the lake. The total amount of ore contained in these veins is very large, and is sufficient to supply the domestic consumption for many years. Now that a method of eliminating the impurities has been devised, it may be hoped that development of the deposits will be undertaken on a larger scale.

In New Brunswick, a small production was reported in the eighties from near Gouldville.

In former years (between 1885 and 1895) a considerable tonnage of barytes was obtained from McKellar island, Lake Superior, where the mineral occurs in a 50-foot vein. Calcite and quartz form a considerable portion of the vein-filling at this point, in consequence of which the ore had to be hand-picked. No mining has been conducted here for a number of years.

Barytes also occurs near Kingston, Ont., and at several other points in the province, but the veins do not possess any economic value.

In Quebec, a small deposit was worked in Hull township in 1900, a small tonnage being extracted. The vein would appear to be worked out.

Barytes is used in paint, putty and lithophone making, as a filler in rubber, and to a lesser extent in the textile, wall paper, tanning, and chemical industries.

The total consumption of barytes in Canada at the present time is given, approximately, as 3,590 tons per annum, six-sevenths of which is imported. Thirty-five firms use the mineral.

FLUORSPAR.

The only important deposits of this mineral so far discovered in Canada are those in the vicinity of Madoc, Ontario, and these are relatively of small size. A 4 foot vein of fluorspar, mixed with chalcopyrite, has long been known near Cape Rouge, in the Cheticamp district, Cape Breton, but no attempt has been made to exploit the occurrence.

The Madoc deposits lie on lot 1, concession IV, of Madoc township, and on lot 10, concession XIV, of Huntingdon. Intermittent mining has taken place at these localities during the past ten years, and a few hundred tons of mineral are reported to have been taken out. The veins are, however, narrow, and the deposits do not possess any great economic value.

Mr. S. Wellington, of Madoc, controls the above properties.

Twenty-five firms in Canada use fluorspar, the amount of consumption being 10,500 tons of imported, and 40 tons of domestic mineral.

INFUSORIAL EARTH OR TRIPOLI.

Large bodies of this material exist at many points in Nova Scotia and New Brunswick, the substance representing recent deposits formed on lake bottoms, and being of an earthy nature as compared with the more compacted material of Tertiary age, known as tripolite, found in other parts of the world.

All of the worked deposits have been rendered accessible by the draining of lakes in which the earth had been found to exist, and it is quite likely that numbers of lakes in the above-mentioned provinces will be found, upon draining, to contain the material. Hitherto, however, the demand for the earth has not been great enough to encourage any active search for new deposits, and mining has been confined in recent years to two localities, both in Nova Scotia.

The more important of these is Silica lake (formerly known as Bass River lake), in Colchester county, about 16 miles from Londonderry, and 12 from Thompson—the shipping point on the Intercolonial railway. The initial work on this deposit was begun over twenty years ago, and practically the whole of the lake bottom has now been worked over and the earth removed. The area of the depression is about twelve acres. In recent years the deposit has been worked by the Oxford Tripolite Company, who employ about twenty hands, and prepare six grades of product. The crude tripoli is dried, and treated on the spot in a mill of 10-ton capacity per diem, the prepared goods being exported to the United States. It is stated that the Company has control of a nearby lake, in which tripoli is known to exist, and which they intend to work when the present deposit becomes exhausted.

The other locality at which infusorial earth has been worked in recent years is near Munro Point, St. Ann's, Cape Breton. The Premier Tripolite Company, of New York, are the present lessees of this deposit, which was worked formerly by the Victoria Tripoli Company. No extraction work has, however, been carried out for a number of years past, though small shipments of crude material have been made from stock from time to time. A small mill for treating the earth exists on the property, but has not been in operation for the last ten years. The area of the drained lake is stated to be about twelve acres, and only a relatively small portion of the available material has been taken out.

An important deposit of tripoli exists in New Brunswick at Fitzgerald lake, about 8 miles east of St. John. There, about 50 acres of tripoli-bearing lake bottom have been rendered accessible by draining operations, the average thickness of the bed being stated to be 10 feet. The deposit has been known for many years, but no attempt at development was made until 1909, when the Boston and St. John Tripolite Company was formed to exploit the occurrence. This Company leased (and continues to lease) the property from the owner, Mr. Wm. Murdoch, of St. John, and in the above year extracted a small quantity of earth, which was air-dried and experimentally treated in a small mill. The operations were soon discontinued, however, and the plant is now in a dilapidated condition. The material appears to be of good grade, and the deposit contains a very large amount of earth, which could be conveniently extracted, and hauled by a good road to St. John for shipment.

In Ontario, there is record of infusorial earth having been found in the Muskoka region near Bala, but no material appears to have been mined.

Tripoli is chiefly used as an abrasive in polishing powders, pastes, and liquids, and in what is known as "grease brick." It is also employed as a filler in rubber goods and woods, as insulating material for steam pipes, boilers, etc., in filters and as an absorbent for nitro-glycerine in dynamite manufacture. There are, in addition, a number of minor uses, and the material is coming more and more into use in a number of industries.

The treatment the crude earth has to undergo is practically the same in all cases, namely, a preliminary drying in kilns; grinding between buhrstones, and final reduction between rolls—though varying degrees of fineness are required for the different trades.

Fourteen firms in Canada use the treated tripoli powder, the total consumption being less than 100 tons, while the number using grease brick is 145, the amount of this material used being about 100 tons. All of this consumption represents imported mineral.

In spite of its many and varied uses, and the number of known deposits in the United States, infusorial earth is not produced in the latter country on a very large scale. The production in 1913 was only 6,500 tons, valued at $70,000—the output coming from eight states, the chief producer being California. The imports are not large, being valued in 1913 at only $28,000. In view of this, and despite the proved existence of large deposits of the material in the Maritime Provinces, and the probable existence of others, the industry is not likely, in the immediate future, to assume any important proportions.

Analyses of Canadian infusorial earth have lately been conducted by N. L. Turner, of the Mines Branch, on samples obtained by the writer last season at the three Maritime localities mentioned above. The results showed:—

—	1.	2.	3.
Silica	74·98	72·10	81·30
Alumina	3·81	......	......
Ferrous iron	0·64	0·51	0·38
Ferric iron	0·72	......	......
Lime	0·54	......	......
Magnesia	0·36	......	......
Soda	0·65	......	......
Potash	0·25	......	......
Water below 110° C	5·74	6·10	5·16
Water above 110° C	9·56	10·70	9·34
Organic	2·72	6·30	0·82

1. Fitzgerald Lake, St. John county, N.B.
2. Premier Tripolite Company's property, St. Ann's bay, Victoria county, C.B.
3. Oxford Tripoli Company's property, Silica lake, Colchester county, N.S.

Only partial analyses were made in the case of Nos. 2 and 3.

MANGANESE.

Manganese is known to occur in the Dominion only in the Provinces of Nova Scotia and New Brunswick. Between 1880 and 1890, a considerable tonnage of high-grade pyrolusite was produced annually, the shipments averaging 1,500 tons. Most of this output was derived from the Tennycape, Walton, and Cheverie deposits in Nova Scotia, and from Markhamville in Kings county, New Brunswick. The mineral occurs here in pocketty aggregates of very pure ore, but the individual pockets are of limited extent and mining is rendered difficult in consequence. No mining has been carried on in this section for a number of years past.

Several deposits of a similar nature are known at various places in the same provinces, and recent reports state that the old Isabella mine, near Loch Lomond, in Richmond county, Cape Breton, has lately been re-opened by the Dominion Iron and Steel Company.

The most important manganese-bearing section in the country is that near New Ross, in Lunenburg county. There, two pyrolusite-manganite lodes enclosed in granite have been worked, one to a depth of 150 feet, and the large amount of manganese float that has been found in the neighbourhood of the mines suggests the probability that other similar veins exist in the district.

The original discovery in this area resulted in the formation of the New Ross Manganese Company, which opened up the most southerly of the known veins and extracted a small tonnage. A large lode was located later (in 1907) about one-fourth mile to the northward of the foregoing, and has been worked (from 1910 to 1912) to a depth of 150 feet by the Nova Scotia Manganese Company. At this depth, levels have been run 140 feet west, and 53 feet east of the shaft, and the existence of a considerable ore-body has been proved. Only about 500 tons of ore is stated to have been extracted, most of which still remains at the mine. The quantity in sight is estimated at about 5,000 tons. Work on the property ceased a couple of years ago, various factors combining to put a stop to operations; one of the chief being the distance the ore has to be hauled (20 miles to Windsor and 29 miles to Chester Basin) to a shipping point, and the lack of a good road. The Company has erected a large mill building at the mine, and partially equipped it with dry-concentrating machinery, which yields three sizes of product. The building is also designed to accommodate wet-concentrating machinery, which, however, has not yet been installed.

Pyrolusite or manganese dioxide, is used in considerable quantities in electric dry batteries; as a colourizer and decolourizer of glass, porcelain, bricks, and enamels; and as a dryer in varnish manufacture. It is also used, but to a decreasing extent, in the manufacture of oxygen, and it is employed in the chemical trade in the preparation of various manganese salts. Pyrolusite contains, theoretically, 60 to 63 per cent of manganese; but ores running as low as 35 per cent are considered "commercial" for the steel trade. The high grade mineral is not much used as a source of the manganese employed in steel manufacture, as the lower grade ore can be obtained more cheaply, and answers the purpose sufficiently well. Market quotations for ore for this purpose are usually for 40–49 per cent mineral.

The New Ross pyrolusite contains about 58 per cent metallic manganese, and 85–90 per cent MnO_2. This degree of purity is the average of most Canadian manganese ores. The mineral is, manifestly, more suitable for the arts than for steel manufacture.

The domestic consumption of high grade pyrolusite is insignificant (less than 20 tons), and consequently the home market has not offered much inducement for any active development of the Maritime deposits. About 1,300 tons of imported lower grade is used, the greater portion of which goes to the dry battery and glass makers. The opportunity for the owners of Canadian deposits to benefit by the cutting off, by the war, of Russian and Indian manganese supplies to the American market has been nullified by the placing of manganese and manganese ores on the prohibited exports list. There would, however, appear to be no reason why the high grade domestic ore cannot take the place of the lower grade imported mineral, for use in the battery, glass, and varnish trades.

TALC.

There are two talc producers in Canada, both in Hastings county, Ontario, at Madoc and Eldorado, respectively, and the greater part of their output is milled locally. Mines and mills were in active operation at the end of 1914, and the year 1913 saw a record output of over 12,000 tons. Both the above deposits are said to contain plenty of talc in sight.

The earlier exploited of the two deposits is the Henderson, on lot 14, concession XIV, township of Huntingdon. Here, the talc occurs in a series of overlapping, more or less upright, lenses, the greatest width of the talc body being about 60 feet. A depth of 250 feet has been reached in the workings, and the mineral is extracted by the square set system and caving. Most of the output is sent to the mill at Madoc, operated by Geo. H. Gillespie and Company; and a small quantity is shipped crude to the United States. Five grades of product are prepared at the above mill, which employs fifteen hands.

The Eldorado deposit—on lots 20 and 21, concessions IV and V, of Madoc township—lies a few miles north of the foregoing, and was opened up in 1911 by the Canadian Talc and Silica Company (now Eldorite, Ltd.). Two shafts have been sunk, 100 and 150 feet deep, respectively. The talc, here, contains rather a large admixture of quartz, which occurs throughout the talc body in small lenses, and has to be cobbed out.

In 1912, a mill was erected, capable of handling 50 tons of product per diem, and has since been in continuous operation.

The same Company has also carried out some development work on lot 15, concession XIV, of Huntingdon, adjacent to the Henderson mine, but has not operated there since 1913.

In addition to the above-mentioned occurrences, talc bodies are found in the province of Quebec, Brome county, on lot 26, range II; lot 24, range VI; and lot 24, range VII, of Bolton township; and on lot 28, range V, of Potton township. A small shipment was made from the second named, in 1871, but most of the material is stated to be dark coloured, and mixed with magnesite.

Talc is used in papermaking; in toilet powders and soaps; for dressing textile fabrics; as a filler in rubber goods, and in enamel paints, composition flooring, etc. Massive talc, or soapstone, is employed cut into various shapes and sizes for stove linings, acid tanks, switchboards, wash tubs and other purposes.

The mineral is used by 170 firms in Canada, the consumption representing over 4,000 tons of domestic, and 750 tons of imported goods.

TUNGSTEN.

Hübnerite float has been found at several localities in Nova Scotia, amongst others near Northeast Margaree, in Inverness county. Wolframite is recorded from various of the gold mines in British Columbia; and Dr. Walker, of Toronto University, has found it, also, in New Brunswick. These occurrences, however, are of little or no economic value, and have never been worked.

More attention has been paid to the mineral scheelite (calcium tungstate), which exists in the form of float at a number of localities in Nova Scotia. It has been found, also, in Ontario, Quebec, and British Columbia, though the latter occurrences are of no economic importance.

In Nova Scotia the most important scheelite locality is Moose river, in Halifax county; the mineral has been found, also, at the Caribou gold mines, north of Moose river; at the Molega gold mines, in Queens county; and near New Ross, in Lunenburg county.

The Moose River occurrence is the only one that has received any serious attention, and the venture, unfortunately, has resulted in failure. Development of the scheelite-arsenopyrite-quartz veins was commenced in 1910, and continued until 1913, by the Scheelite Mines, Ltd. A concentrating plant was erected, and in 1912 a shipment of 14 tons of scheelite concentrates, carrying 72 per cent tungstic acid, was made. The hopes that the scheelite content of the veins would persist in depth were, however, not realized, and all operations were suspended in 1913, owing to lack of ore. Although surface indications were regarded as quite promising, undue importance was certainly attached to the occurrence, which was also the case with the Molega and New Ross discoveries. The latter is never likely to prove more than merely an interesting mineralogical association of tin, tungsten, and other minerals in very small quantity, and the prominence given to it in various reports and technical journals, etc., is to be regretted, since it has given the impression that the above minerals occur, possibly, in economic quantities, which is not the case.

There is no probability that tungsten will be found in paying quantities in the areas mentioned above, nor can it be regarded as likely that economic deposits of tungsten minerals will be discovered within the Dominion.

Tungsten is used in hardening steel and for electric light filaments, while tungstic acid is utilized in weighting silk and fireproofing textile fabrics. The domestic consumption is negligible.

III.

INVESTIGATION OF THE SAND AREAS OF THE PROVINCE OF QUEBEC.

L. HEBER COLE.

During the field season of 1914, the writer, with Mr. J. Ross Taylor as assistant, was engaged in the study of the sands and sandstones of the province of Quebec, with a view to determining their suitability for use in the building and manufacturing industries. In this investigation special search was made for sands suitable for glass manufacture and for foundry purposes.

The field work was carried out as follows: the sand areas to be investigated were first traversed hurriedly, by driving and walking, in order to map out the various boundaries. These boundaries were, generally, located easily and with sufficient accuracy, from the main and cross roads. Wherever the roads were far apart, the boundary was determined by means of a compass and pacing traverse; and where the boundary was not clearly defined on the surface, a series of test holes were drilled on a line at right angles to the supposed boundary, and from these borings the limits of the sand areas were determined. After the boundaries were located, all the sand pits were thoroughly examined and sampled, as also were any other exposures, such as railroad cuts, river banks, etc., which afforded a favourable opportunity for investigation. In addition to the above samples, others were taken at different parts of the areas by boring a 6-inch hole with an auger drill to a depth, wherever possible, of 20 feet. Five-pound samples were taken, except in the case of a possible moulding sand, when an 80-pound sample was obtained.

A rough analysis of the sand in the various areas was made in the field, by washing, to determine the amount of silt; and with a magnet to determine the percentage of magnetic material.

The district first investigated was that situated between the St. Lawrence and Ottawa rivers, and the eastern boundary of Ontario; after which the district north of the Ottawa and St. Lawrence rivers, between a point 7 miles west of Lachute and as far east as Grand Mère, was examined. An investigation was also made of the sands exposed on either bank of the St. Lawrence river between Montreal and Quebec, as well as of the sands from the bottom of the river, when obtainable.

None of the sands examined gave promise of being suitable for the manufacture of glass; and only three samples were obtained which gave indications of being adapted for foundry work. Several samples of crushed sandstone were obtained with a view to determining their suitability in the glass-making industry; the remainder were taken in order to test their value for building purposes.

Some 150 samples were obtained and shipped to Ottawa, where it is intended to subject them to a series of tests to determine the class of work for which they are best suited.

The investigation is to be continued during the season of 1915.

IV.

BITUMINOUS SANDS OF NORTHERN ALBERTA.

S. C. ELLS.

The work of the past season was a continuation of that of the preceding year. In 1913, a brief reconnaissance of the deposits of bituminous sand was undertaken. As a result of that reconnaissance, the writer considered that indications warranted a practical test of the bituminous sand as a possible paving material. The selection and mining of a trial shipment constituted, therefore, the chief feature of the past season's field work. As in the previous year, the work was unfortunately handicapped by a short field season, a consideration which adversely affected the efficiency of the party.

In the selection of a trial shipment of bituminous sand for experimental purposes, very considerable care was required; more particularly in an entirely undeveloped and unproven field. This fact had been emphasized by the results of the reconnaissance of the previous year, and, in a report prepared at that time, various outstanding features were briefly alluded to[1].

In the preliminary reconnaissance work already referred to, wide variation in the grading of the mineral aggregate was clearly recognized. This variation characterized not only separate outcrops, but was also observed within comparatively narrow limits in individual outcrops. Similarly, it was early recognized that very considerable variation would be found in the percentage of the bitumen content. Unimpregnated partings of clays, lignitic particles, gravel, and other undesirable material, constituted another feature to be carefully considered.

During the field season of 1913, and over an area exceeding 750 square miles, upwards of 250 separate outcrops of bituminous sand had been noted. In view of the considerations stated above, a certain degree of care was required in the selection of the point, or points, from which material might best be taken for demonstration purposes.

At the outset, it was possible to eliminate a number of the recognized outcrops from further consideration. In so doing, the results of the analyses of samples secured in 1913, and obvious transportation difficulties in handling a trial shipment like that contemplated, served as a basis.

In mining a trial shipment, it was deemed desirable that the outcrop or outcrops selected should be such as might, later on, lend themselves to development on a commercial scale (Plates VI, VII).[2] Any results obtained through the use of material from unworkable deposits might obviously convey an entirely wrong impression as to the probable economic value of the deposits as a whole.

In undertaking the examination of those deposits which appeared to conform to the requirements determined upon, the overburden, when present, was first removed by pick and shovel, supplemented, at times, by the use of explosives (Plates I, II, III). Specially designed augers[3] (Plate IX) were then sunk to the required depth, in 12 to 14 foot lifts, and an accurate core sample thus obtained. The entire core was then placed in a rotary mixer, and thoroughly mixed. An 8- to 10-pound sample was then taken from the mixer, and gently warmed in a large iron pot. As the material became softened, it was further mixed by constant agitation with a large metal spoon. Finally, a sample of 150 to 250 grams was taken for analysis. In certain cases where, for various reasons, core samples could only be obtained with considerable difficulty, a fresh vertical section of the outcrop was exposed by the use of pick and shovel. Along this section, small samples were then taken at intervals of about 4 inches, and to a depth of about 3 inches. In this work, a small circular cheese scoop was used, with satisfactory results. In such cases, as with the auger cores, the various fragments were combined, mixed, and the small sample secured for final determination.

As the result of a series of tests made in the writer's laboratory in Ottawa, it had been found that bitumens extracted from samples of bituminous sand from various parts of the McMurray area did not materially differ in their chemical and physical characteristics. Consequently, the only tests made in the field comprised a careful grading of the mineral aggregate, together with a determination of the approximate percentage of the bitumen content. In this work, but little apparatus was required. The weighed samples were placed in tall copper beakers, covered with benzol, and agitated. Bitumen and solvent were then carefully decanted through filters; the process of adding solvent, and decanting, being repeated until only the clean mineral aggregate remained. The sand recovered on the filter papers, together with that still remaining in the beakers, was then dried and weighed, and the percentage of the bitumen content determined by calculation. Allowance was also made for the presence of mechanically combined moisture, the correction applied being the average result of careful tests of a number of samples previously determined in the Ottawa laboratory. The dried sand was then carefully graded through a complete set of standard sieves. A sand scale, checked by the use of an accurate balance, was used in all weighings.

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[1] Preliminary Report on Bituminous Sands of Northern Alberta.

[2] In choosing the outcrops from which bituminous sand was eventually taken, it has been assumed that they are adapted to commercial development. Only careful and systematic prospecting with suitable equipment will, however, definitely determine their true value.

[3] For complete descriptions see Preliminary Report on Bituminous Sands of Northern Alberta.

In this manner some 72 samples were tested during the field season. The following results of samples taken from the more important outcrops furnish the most accurate information available at the present time, and probably represent fairly well the general character of the bituminous sands of the whole McMurray area:—

Number and Origin of Sample.	Miles from mouth.	Passing Mesh.										
		200	100	80	50	40	30	20	10	Over size.	Clay lignite etc.	Percentage of bitumen content.
No. 1. Horse creek..............	1·5	6	61	13	19	....	....	....	...	.....	......	16
2. " "	1·5	3	60	14	22	....	....	....	...	......	...	16
3. " "	1·5	7	52	22	16	1	....	....	....	...	......	15
4. " "	2·5	5	41	12	40	1	....	....	....	.....	......	14
5. " "	3·7	8	33	5	55	1	1	....	....	.....	...	11
6. Athabaska river... ...	....	9	55	6	22	1	1	...	2	2	......	16
7. East side ½ mile south of	....	7	11	3	43	16	10	5	2	......	.....	14
8. McMurray...... .. .	....	4·5	43·5	6	44	1	·5	....	...	......	......	15·5
9. Athabaska river, Howard claim...	......	4	5	1	9	11	16	26	30	5	....	14
10. Athabaska river, Murphy claim.	....	2	4	1	6	7	16	35	29	1	....	13
11. Athabaska river, 6·5 miles below Pierre au Calumet	....	2	24	9	60	4	2	....	...	.	......	12
12. Hangingstone creek.....	2·5	1·5	4	2	64	25	4	....	....	.....	...	14·5
13. " "	2·7	6	13	2	72	2	3	...	....	......	......	15
14. " "	3·4	5	21	1	39	19	4	8	....	......	......	15
15. " "	3·9	5·5	24	5	61	1	5	1	....	......	......	10
16. Clearwater river.... .. .	1·5	3	7	3	57	8	9	6	5	....	.....	15
17. Steepbank river..........	3·8	2·5	8	2	39	15	8	8	8	8	....	14
18. " "	4·3	7	4	1	12	10	17	27	22	. ..	.... .	15
19. " "	4·8	3·5	3	2	80 5	6·5	2	2	....	......	......	16
20. " "	5·5	3	9	1	33	31	14	6	1	......	...	14·5
21. " "	7·1	3	14	2	72	5	5	1	...	... .	......	16
22. " "	7·5	2	11	5	78	4	2	1	....	......	.....	17
23. " "	8·5	5	33	2	43	7	4	2	....	....	......	16
24. " "	10·5	3	8	2	25	16	20	16	9	.. .	.. .	14
25. " "	....	3	6	13	15	21	14	18	8	.....	.....	11
26. Muskeg river.	7·5	7	10	1	27	20	16	10	6	.....	......	8
27. McKay river.	·6	1	20	3	67	5	....	....	....	....	2	14
28. " "	9·1	2	45	6	37	3	....	....	....	....	6	13
29. " "	11·0	5	55	13	16	6	....	....	....	... .	5	15
30. " "	11·4	3	39	4	35	8	....	....	....	.....	8	15
31. " "	12·9	6	53	8	8	2	....	..	....	......	19	14
32. " "	14 6	2	18	4	70	1	..	....	...	....	2	15
33. " "	17·8	2	21	4	55	15	2	....	....	......	.....	14
34. " "	19·3	2	62	14	17	1	....	3	. .	. ...	.....	11
35. Moose river....	3·5	4	21	41	15	8	6	4	1	......	.....	11
36. " "	3·4	9	42	5	30	6	2	2	1	......	1	11
37. " "	5·6	10	77	5	6	1	....	....	....	....	.. .	12
38. " "	6·1	4	32	6	50	4	....	....	...	......	4	12
39. " "	6·1	12	57	7	19	1	2	...	....		......	13

From a scrutiny of the above table, the difficulty of obtaining a sand that will conform to standard specifications for sheet asphalt will at once be seen. It was, therefore, decided to combine material from two outcrops in such a proportion that a close approximation to the desired grading would be secured. Approximately, 57 tons of bituminous sand were then mined, sacked, and stored. (Plates II, VIII.)

It is hoped that during the winter and spring of 1915, this shipment will be transported to Edmonton, for the purpose of laying a small section of experimental pavement for demonstration purposes.

Finally, it may be added that the work of the past season has confirmed, in general, conclusions already stated in the writer's report on work of the previous year. In that report the following statement appeared:—

> ". . . In the McMurray district there is thus a very large body of bituminous sand, the prospecting and development of which will be confined to stream valleys. Only after careful exploration by means of adequate equipment can the true value of any deposit be affirmed. Nevertheless, owing to heavy overburden (Plate V) and lack of uniformity in the quality of the bituminous sand, it is probable that quite 80 per cent of the exposures may be eliminated from further consideration at the present time. Considerations affecting transportation will still further reduce the remaining number. Certain of the outcrops should, however, lend themselves to development on a commercial scale."

In considering the derivation of by-products from bituminous sands, the possibility of extracting nitrogen at once suggests itself, and the writer has been frequently asked whether the bitumen content might be considered as a possible source of ammonium. In Scotland, at the present time, the success of the oil shale industry depends largely on the chief by-product, namely, sulphate of ammonia. The ultimate composition of representative samples of Broxburn shales gives nitrogen from 0.54 to 0·94 per cent. This nitrogen is derived from organic matter in the shales, and when converted into ammonium corresponds to 57—59 pounds of ammonium sulphate per ton of shale.

The nitrogen contained in two samples of bitumen extracted from the Alberta bituminous sand was determined[1] to be 0·3 to 0·4 per cent. It should be remembered, however, that in the case of the Scotch shales the percentage of nitrogen as stated is based on one ton of shale as mined. In the case of the Alberta sands, the percentage of nitrogen is based on the extracted bitumen only. Assuming that the extracted bitumen represents 15 per cent by weight of the crude bituminous sand, it will be seen that the nitrogen that could be derived would thus be equivalent to 0·045 to 0·06 per cent of the crude bituminous sand. Such a meagre percentage of nitrogen renders its utilization entirely out of the question.

During the course of the season's work, fragments of iron ore float — up to 15 pounds in weight — were found at a number of points on Steepbank and Moose rivers. At a point on Steepbank river, 4·9 miles from the mouth, two small excavations, 40 feet apart, were made in the northeast bank. In each instance a thin capping of bituminous sand overlies a compacted bed, one to two feet in thickness, and made up of fragments of siderite up to 20 pounds in weight. These fragments are not waterworn nor pitted as would be the case with float that had been carried any distance. A bed of clay, one to four feet in thickness, underlies the iron ore, and itself rests upon well bedded Devonian limestones.

A representative sample of the iron ore analysed by Mr. H. A. Leverin gave:— iron, 35 per cent; insoluble, 18 per cent. So far as the writer's limited observation has gone, this deposit has no economic value.

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[1] Determination by E. Stansfield.

It may be added that clay ironstone, in the form of impure siderite, has a fairly wide distribution, in association with rocks of Cretaceous age, in the western provinces of Canada. In some instances the deposits appear to be due to a silting out of the fragments of ore from the softer rocks of the formation. In no instance, however, have beds of economic importance been discovered in this area.

Samples of mineral water were also secured at four points in the McMurray district. These samples were submitted to the Division of Chemistry for analysis,[1] with the following results:—

No. 1. Overflow from casing-head of No. 1 well, Athabasca Oils, Ltd., Athabaska river.

No. 2. Overflow from casing-head of "Salt of the Earth" well. Sunk by A. von Hammerstein, on west bank Athabaska river, 1 mile north of McKay.

No. 3. From largest spring at La Saline lake.

No. 4. Overflow from casing of well drilled by Fort McKay Oil and Asphalt Company, at La Saline (August, 1914).

RESULTS OF ANALYSES.

—	No. 1.		No. 2.		No. .		No. 4.	
	Parts per million.	Grm. per Imp. gallon.	Parts per million.	Grm. per Imp. gallon.	Parts per million.	Grm. per Imp. gallon.	Parts per million.	Grm. per Imp. gallon.
Ca	1638	109·5	1347	832·0	1821	121·1	3354	204·1
Mg	385	25·7	585	36·1	571	38·0	1021	62·1
K	296	19·7	336	20·7	496	33·0	192	11·6
Na	22988	1537·6	76268	4720·0	21184	1409·0	84076	5117·7
HCO_3	469	31·3	372	22·9	530	35·0	36·0	2·1
CO_3	none.	none.	none.	none.	none.	none.	none.	none.
Cl	36188	2419·5	118636	7329·3	39792	2647·0	127960	7788·9
SO_4	4144	277·0	4920	304·0	4688	312·0	2956	179·9
Sp. Gr. at 15·5°C	1·047		1·133		1·052		1·150	

On the conclusion of the season's work, the writer, accompanied by one man, returned to Edmonton, via Methye portage and Prince Albert, and an attempt was made to secure some definite information regarding other reported outlying deposits of bituminous sand. An assistant, Mr. C. R. Ritson, together with the remainder of the party, returned to Athabaska direct via the Athabaska river.

From time to time have appeared more or less unauthentic references to asphaltic deposits at or near the Upper Narrows on Buffalo lake, Sask., and in or near township 79, range 19, W. of the 3rd meridian. On both sides of the Narrows, small excavations were made by the writer, and former excavations were examined.

On the east side, only a few small fragments of bituminous sand float—none over two pounds in weight—were found. These fragments were of low grade, and evidently much altered by the action of water.

On the west side of the Narrows (Plate XI) what appeared to be low ledges of bituminous sand were found. A small amount of excavation showed these to be masses of float, the largest weighing, possibly, 5 to 8 tons. It is impossible to say whether the main body from which these masses were derived occurs near by, or whether the bituminous sand has been transported a considerable distance. The character of the material is similar to that found at McMurray. Careful enquiry among natives and settlers between Methye portage and Ile à la Crosse failed to elicit any information regarding other local occurrences.

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[1] Analyses by Mr. N. L. Turner.

For the most part the country to the east and west of La Loche river, La Loche lake, and Buffalo lake, is low-lying; while the infrequent and limited sections exposed indicate the presence of a heavy blanket of glacial and post-glacial material. Everywhere there is a fairly heavy forest growth, consisting of poplar, birch, and spruce. To the west of Buffalo lake the ground rises gradually. Buffalo river, the largest tributary entering from the west, was ascended for some 28 or 30 miles, but no rock in place was seen. Under conditions such as the above, prospecting for bituminous sands will probably present considerable difficulty.

In ascending the Athabaska, Mr. Ritson made a hurried examination of an exposure of coal which outcrops through a distance of some 15 miles, on both sides of the river, above and below Grand Rapid. In passing down the Athabaska, in June, outcroppings of this seam, at a number of points, had been readily seen from the middle of the river.

According to Mr. Ritson, the seam lies just above the Grand Rapids sandstone, and varies in thickness from 3 to 15 feet. Owing to frequent and extensive clay and rock slides, a complete examination would necessitate considerable excavation.

It appears that the seam contains a large percentage of impurities, consisting principally of clay partings. Thin bands of fairly clean lignite from 1 to 2½ feet in thickness were, however, noted.

A sample taken from one of these narrower bands, and at a depth of 4 feet from the face, gave the following analysis[1]:

Moisture	3·2	per cent.
Ash	75·8	"
Volatile matter	13·8	"
Fixed carbon (by difference)	7·2	"

Laboratory Tests of Clay Samples from McMurray Area.

Incidental to the investigation of the bituminous sands, small samples of clays were secured by the writer at a number of points in the McMurray area during the field season of 1914. In most instances the thickness and extent of individual beds could not be determined without an undue amount of boring and excavation. All the clays referred to, either immediately overlie the Devonian limestone, or are associated with the Dakota sands.

It is considered that the samples secured will indicate, fairly well, the general character of clays in that portion of the area referred to. At the same time it should be remembered that, in work of a purely reconnaissance nature, the samples taken represent only a small percentage of all deposits, and that prospecting of a more detailed nature may discover still other types of clays of economic value.

An excessive percentage of carbon is noted in the case of certain of the samples examined. Where the clay lies between the bituminous sand and the Devonian limestone, this contained carbon has been largely, if not altogether, derived from the overlying bituminous sand. It is probable that such contamination would materially decrease on working in from the outcrop.

In the following notes actual extent and thickness of overburden are not stated. To secure accurate data regarding this very important feature will require further detailed work in the case of each individual deposit. The question of transportation will also require careful consideration.

In considering a possible fuel supply, it may be stated that workable beds of coal have not, as yet, been found in this part of the province of Alberta. There is, however, a fairly large supply of birch and poplar along most of the streams. It appears possible that intelligent prospecting may discover fuel gas in commercial quantity.

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[1] Analysis by E. Stansfield.

All the laboratory work necessary for a full series of physical tests, in order to determine the industrial value of the clays, was done by the writer, under the direction of Mr. Joseph Keele, and comments on the results of the tests were written by him.

LOCATION, AND RESULTS OF TESTS OF CLAY SAMPLES.

Steepbank River.

Steepbank river enters the Athabaska from the east, 21·5 miles north of McMurray. Along both sides, frequent exposures of clays were observed throughout a distance of 17 miles from the mouth. Samples 302, 303, and 304 are from points 4·9, 4·2, and 2·3 miles, respectively, from the mouth. A small amount of excavation would uncover other outcrops in addition to those from which the above samples were taken.

The overburden along this stream will, in most instances, be very heavy.

Laboratory No. 302.—This is a grey, highly plastic, fine grained clay, requiring 28 per cent of water for tempering. It has good working qualities. The drying shrinkage is 8 per cent. It must be dried slowly to avoid cracking.

On burning to cone 010, a dense, steel-hard body is produced, having an absorption of 10 per cent, and fire shrinkage of 1·3 per cent. If burned to cone 06, the absorption is reduced to 4 per cent, but the fire shrinkage is too high, being 4·6 per cent.

Burning to higher temperatures produces bloating, unless the firing is done very slowly. The clay is intact at cone 3, and will probably stand a much higher temperature, but the presence of carbonaceous matter is a defect, and interferes with the development of a good product.

Laboratory No. 303.—This clay is light grey in colour, and rather calcareous. It requires 27 per cent of water for tempering; the working qualities are good; the wet body is fairly smooth and free from coarse grit. The clay can be dried as fast as desired after moulding, the drying shrinkage being 5·8 per cent. The following results were obtained on burning:—

Cone.	Fire Shrinkage.	Absorption.	Colour.
	%	%	
010	0	25	Salmon
06	0	25	Pink
03	0	23	Buff
3	Fused.	....	....

This clay is suitable for the manufacture of common building brick, either by the stiff mud or soft mud process; but must be burned to cone 03 to secure the best results. It is a typical calcareous brick clay, which is used largely for the manufacture of clay products in many parts of Canada. The buff colour developed in burning is due to the presence of a high percentage of lime.

Laboratory No. 304.—This material evidently contains thin bands of limestone interbedded with the clay or shale. The limestone bands are not visible on the weathered outcrops, or in the talus at the foot of the bank, as they soften like the shale.

The numerous white particles seen in the red body of the material, after burning, are lime oxide. These particles will absorb moisture from the air, and, on swelling, break up the burned ware.

In the case of clay No. 303, the lime is in a very finely divided state, and consequently, harmless.

While this clay is not recommended for the manufacture of clay products, it may be useful for Portland cement, if some more limestone is added.

Muskeg River.

Muskeg river enters the Athabaska 31 miles north of McMurray. Samples 190, 305, 306, 308, and 309 were taken from points along the lower 4 miles of its course.

None of the beds from which samples were taken are exposed to a thickness that would warrant commercial development; and a considerable amount of exploration will be necessary to demonstrate their value. In certain instances, however, the thickness of overburden should not prove prohibitive, and transportation to the Athabaska presents no serious difficulties.

Laboratory No. 190.—From point on northwest shore of Muskeg river, between head of portage and mouth of river.

A light grey, very plastic clay, with good working and drying qualities. It burns to a cream coloured, dense, steel-hard body at cone 3, with a total shrinkage of 9 per cent, and softens when heated up to the temperature of cone 27. This is a good example of a stoneware clay, and is also a fire-clay. It is the most refractory clay at present known to occur in the province of Alberta.

Laboratory No. 305.—Light grey clay.

This clay has good plasticity and working qualities when tempered with 27 per cent of water. It is fairly smooth to the feel, and free from coarse grit. The shrinkage on drying is 8 per cent, and fast drying can be accomplished safely without cracking the ware.

The following results were obtained on burning:—

Cone.	Fire Shrinkage.	Absorption.	Colour.
	%	%	
010	·7	11	Light red
06	1·0	4	Red
03	4·0	0	Dark red
3	Begins to soften.	....	....

This is a good, red burning clay, suitable for the manufacture of rough clay products, such as building brick and hollow block. The shrinkages are rather high, but this would be overcome by adding about 20 per cent of sand. This clay would also be useful for mixing with one of the higher grade clays in this vicinity for the manufacture of vitrified wares.

Laboratory No. 306.—This clay requires 37 per cent of water to bring it to a good working consistency. The effect of this large quantity of water is evident in the high drying shrinkage, which is 10 per cent.

A steel-hard, light red body is produced at cone 010, having an absorption of 12 per cent, and a fire shrinkage of 1·3 per cent.

When burned to a higher temperature, the colour is improved, but the fire shrinkage is too high. With the addition of 25 per cent of sand, this clay would be suitable for the manufacture of common brick.

Laboratory No. 308.—This is a red burning clay, similar to 306, but the shrinkages are not quite so high. When mixed with 25 per cent of sand and burned to cone 010, a good strong common brick can be made from it.

Laboratory No. 309.—This is another red burning clay, similar to 306 and 308, but the shrinkages in drying and burning are less than these.

It burns to a light red, steel-hard, dense body at cone 010, with a total shrinkage of 10 per cent. When mixed with about 25 per cent of sand, it could be used for common brick. It must be burned slowly on account of the carbon it contains. A test piece burned to cone 03 had a black core, and was bloated, owing to this cause.

McKay River.

The McKay river enters the Athabaska from the west, some 34 miles north of McMurray. Outcrops of clay were observed along the lower thirty miles of its course.

Samples 310, 311, and 312 were taken at points 11·2, 26·7, and 27·2 miles from the mouth.

Sample No. 311 represents a large deposit, the development of which should present no serious difficulty. Samples 310 and 312 represent deposits regarding the extent of which little can be stated, owing to slide and talus piles. In all three cases transportation to the Athabaska will present considerable difficulty.

Laboratory No. 310.—This clay requires 23 per cent of water to bring it to the best working consistency. It is very plastic, and smooth. The drying must be done slowly after moulding, to avoid cracking. The drying shrinkage is about 7 per cent. The results obtained in burning are as follows:—

Cone.	Fire shrinkage.	Absorption.	Colour.
	%	%	
010	0	10	Buff.
06	1·4	8	"
03	3·0	3	"
1	3·4	2	Dark buff.
5	2·0	0	Grey.
15	Fused.		

This is one of the better grades of clay, with good working qualities, and shrinkages within commercial limits. It would be suitable for the manufacture of hard burned fireproofing buff face bricks, or sewer pipe. The drying qualities could be improved by the addition of a small percentage of ground-burned clay to the raw clay. It must be burned slowly.

Laboratory No. 311.—This clay requires 26 per cent of water for tempering. It has fairly good working properties, but the wet body is rather short on account of a considerable quantity of fine grained silt being present. It stands fast drying without cracking, after moulding.

Owing to its silty content, this clay has lower shrinkages than any of the red burning clays already described. It will make a good common red brick when burned to cone 010, but the colour and body are improved by burning to cone 06. It is overfired at cone 03.

Laboratory No. 312.—This is a low grade, red burning clay, which has several defects, such as cracking in drying and firing, and excessive shrinkages. It is useless for the manufacture of clay products.

Moose River.

The Moose river enters the Athabaska some 47 miles north of McMurray. Outcrops of clay were observed at intervals throughout the distance that this stream was ascended, namely 16 miles.

Samples 187, 191, 313, 314, 315, 316, 316A, and 317 were taken at points 6·8, 3·3, 6·75, 6·7, 6·6, 5·6, 1·8 and 2·2 miles respectively from the mouth. As elsewhere in the district, slide and talus obscured the greater part of each deposit. The largest single exposure was that from which sample 315 was taken. Here the clay has an exposed thickness of 16 feet, and an exposed length of 170 feet. What appears to be the same bed of clay re-appears some 700 feet below the outcrop from which sample 315 was taken.

Along the contact between the clay and overlying bituminous sand, fragments of pyrite float up to 15 pounds in weight, as well as pieces of carbonized wood, were found.

Laboratory No. 187.—Dark grey, nearly black clay, underlying bituminous sand.

This clay is very plastic, fine grained, and smooth. It works up rather stiff and slightly sticky. Dries very slowly, with a drying shrinkage of 6·5 per cent. This clay contains such a large percentage of asphaltic carbon, that it is very hard to burn without swelling, unless burned very slowly during the oxidation stage. The density of body, due to the extreme fineness of grain, interferes with the expulsion of carbon, so that the oxidizing process of this clay is tedious.

The clay burns to a light red colour at the lower temperatures, and to a buff or grey at higher. It vitrifies about cone 5, and is fused at cone 20.

This clay is of the stoneware type, but the carbon it contains is a detriment.

Laboratory No. 191.—From Moose river, interbedded between bituminous sand and Devonian limestone.

Dark grey, very plastic, smooth, fine grained clay of the stoneware type. Burns to a salmon coloured dense body at cone 3, with rather high shrinkage, and fuses at cone 18.

Laboratory No. 313.—This clay only required 14 per cent of water for tempering, owing to the presence of a large percentage of rather fine grained quartz sand. The plasticity and working qualities were low for this reason.

The drying shrinkage was only 3 per cent.

The following results were obtained on burning:—

Cone.	Fire shrinkage.	Absorption.	Colour.
	%	%	
010	0	8	Salmon.
06	0	8	Buff.
03	0	8	"
5	0	7	"
14	Begins to soften.		Grey.
18	Fused.		

As this clay is too sandy to use alone, a mixture was made by adding 50 per cent of a fat clay (315) from a near by locality. This gave a body with properties intermediate between the two extremes of a highly plastic clay with large shrinkage, and a lean clay with low shrinkage, so that the results obtained in working and burning were good. The air shrinkage was about 5 per cent. A steel-hard, practically non-absorbent body was produced at cone 1.

This mixture would probably be suitable for sewer pipe, or electrical conduits.

Laboratory No. 314.—This is a soft grey clay, with good plasticity and working qualities. Wares moulded from it will stand fast drying without checking.

The drying shrinkage is 6 per cent.

The following data were obtained on burning:—

Cone.	Fire shrinkage.	Absorption.	Colour.
	%	%	
010	0	12	Salmon.
06	1·0	9	"
03	2 3	5	"
1	3·4	1	Buff.
5	4·6	0	Grey.
9	Intact.		
14	Softens.		

This is a good material, the shrinkages are low, and it gives no trouble on burning. It would be useful for the manufacture of face brick, fireproofing, electrical conduits or sewer pipe.

Laboratory No. 315.—This is a soft grey clay, very plastic and smooth when tempered with water. It is rather stiff and hard to work, but its working qualities could be improved by the addition of some ground calcined clay, or 'grog' as it is termed in the clay-working industry.

The clay contains a certain amount of carbon, which will give trouble in burning unless this operation is done very slowly. It burns to a dense body at low temperatures, the colours being salmon to grey. It develops fire checks, and becomes brittle at higher temperatures.

Samples of 3-inch, round hollow tile were made from this clay and sent to a commercial sewer-pipe works for salt glazing.

Salt glazing test: This material came from the kiln with a uniform bright salt glaze of a rich light brown colour.

The body was vitrified but the shrinkage was rather high, showing the necessity for the addition of some coarse material.

The results of this test show that a fine salt glaze can be applied to this clay at cone 3.

Laboratory No. 316.—This clay requires 21 per cent of water to bring it to a working consistency. The plasticity is good, and the clay is smooth to the feel.

It must be dried slowly after moulding, as checking may occur if the drying is forced.

The drying shrinkage is 6 per cent, and the following results were obtained on burning:—

Cone.	Fire shrinkage.	Absorption.	Colour.
	%	%	
010	1·3	9	Salmon.
06	2·6	7	"
03	3·7	2	"
1	4	0	Grey.
13	Fused.		

This clay behaves well at all stages of burning up to cone 1, when it becomes vitrified. When burned to cone 3, the test piece showed blistering on the surface and a honeycombed body, but this may be due to raising the temperature too fast, because the clay does not actually melt until cone 13 is reached.

Laboratory No. 316A.—This is a light brown silty clay, with low plasticity, and poor working qualities.

It burns to a porous red body at low temperatures, and melts about cone 3.

The only use this clay would have in the clay-working industry is the production of an indifferent common building brick.

Laboratory No. 317.—Light grey clay, with slightly reddish tinge, requiring only 17 per cent of water for tempering. It is rather stiff in working when wet; the plasticity is good, and the clay is very smooth. The drying qualities were not tested, but they are probably good, owing to the small amount of water required to bring it to a working condition.

The drying shrinkage is 5 per cent, and the following results were obtained on burning:—

Cone.	Fire shrinkage.	Absorption.	Colour.
	%	%	
010	0	10	Salmon.
06	0	10	"
03	1	7	Buff.
1	1	6	"
5	2	3	Grey.
9	4	Vitrified.	"
16	Fused.		

This is a stoneware clay suitable for the manufacture of pottery, crocks, jars, teapots, etc. It would require some experimental work to fit the bodies with suitable glazes, but it is probable that the usual Bristol and slip glazes used for stoneware articles would answer.

Some 3-inch round hollow tile was made on a hand press, and sent to a commercial sewer-pipe plant for a salt-glazing test.

Salt-glazing test: The results of the salt glaze tests on this clay show that the glaze cannot be successfully applied at cone 3, as that temperature is too low. The body showed no sign of vitrification, being still porous and rather soft.

It would require a temperature in the kiln of at least cone 5, or better, at cone 6, to produce a glaze on this clay. It will then show a glaze equal to number 315, but of lighter colour. The commercial kiln in which the tests were made did not give a higher temperature than cone 3, hence it was impossible to complete the test on this clay.

Laboratory No. 318.—Is from the west bank of the Athabaska river, about 1½ miles south of the Moose river. The clay bed has a thickness of at least 9 feet, and appears to extend for a considerable distance. The overburden includes from 10 to 15 feet of low-grade bituminous sand, but does not appear to be of prohibitive thickness.

This is fine grained, highly plastic, rather sticky clay, requiring 25 per cent of water to bring it to the best working consistency. It must be dried slowly after moulding, to avoid checking. The drying shrinkage is 7·5 per cent.

It burns to a salmon coloured, steel-hard body at cone 010.

This clay contains a certain amount of carbon, which is expelled with difficulty during burning, owing to the fineness of grain and density of body, so that swelling ensues at higher temperatures unless burned very slowly.

Laboratory Nos. 319 and 320.—Are from the point near which the southerly boundary of the Murphy bituminous sand claim meets the east shore of the Athabaska river. Owing to the slide and talus, the thickness of the clay could not readily be accurately determined, but appears to be quite 20 feet. At the points from which the samples were taken the overburden appears to consist of from 10 to 20 feet of low grade bituminous sand. What appear to be extensions of the same bed re-appear along the river at intervals for one-third of a mile to the south of the point where samples were secured.

Laboratory No. 319.—A light grey, highly plastic and smooth clay, with good working properties. It must be dried slowly, being liable to check, if dried too fast. The drying shrinkage is 5·5 per cent.

The following results were obtained on burning:—

Cone.	Fire Shrinkage.	Absorption.	Colour.
	%	%	
010	0	11	Salmon.
06	0	10	"
03	·6	8	Buff.
1	1·3	6	"
5	2	5	Grey.
9	4	Vitrified.	"
17	Fused.		

This is a typical stoneware clay, suitable for the manufacture of all classes of stoneware articles, and pottery.

It is not a fire-clay, but may be sufficiently refractory for stove linings, boiler-setting blocks, or other purposes where extremely high temperatures would not be used.

This is one of the best clays of the series; it closely resembles No. 317, which is almost as good. It is not so refractory as No. 190, which stands up at the highest temperature of any of these clays.

Laboratory No. 320.—A highly plastic rather sticky clay, when wetted, being stiff and hard to work. It requires to be dried slowly after moulding. The shrinkage on drying is 9 per cent, which is rather too great.

It burns to a dull salmon colour and steel-hard body at cone 010. Considerable trouble is experienced when burning this clay at higher temperatures, on account of the carbonaceous matter it contains. It fuses about cone 4. Owing to the carbon, high shrinkage, and low fusibility, this clay is not of much value.

Laboratory No. 321 is from the west bank of the Athabaska river, at a point about 1½ miles north of the mouth of the Calumet. It rests on Devonian limestone, but has no capping of bituminous sand. The exposed face is over 300 feet long, and upwards of 40 feet in thickness. The overburden is relatively light.

This is a light yellow, highly calcareous clay, with rather low plasticity, so that the wet body is short and crumbly in working.

It burns to a very porous, chalky, buff-coloured body at cone 03, on account of the high percentage of finely divided lime it contains. This clay has little or no value.

Laboratory No. 188.—From east bank of Athabaska river, one-third mile above McMurray, Alberta.

A dark grey clay, exceedingly plastic, and smooth, smelling strongly of asphalt when damp.

It burns to a light red colour at a low temperature, becoming grey when heated up to cone 5, or thereabouts.

It fuses at cone 16.

Owing to its fineness of grain, and to the fact that it contains a certain percentage of asphaltic carbon, this clay is very hard to burn. It could not be used unless a certain amount of it were calcined, ground, and added to the raw clay. This would improve its working, drying, and burning qualities.

Laboratory No. 189.—Mottled, light red clay, from north bank of Firebag river, one-fourth of a mile above first rapid.

This is a very plastic and rather sticky clay. It burns to a red vitrified body at cone 3, but the shrinkages are rather high. It fuses about cone 10. This clay may be suitable for the manufacture of sewer pipe.

Laboratory Nos. 188, 189, 190, and 191 are alike in many of their physical characteristics, and appear to occur in the same geological horizon—viz., underlying the tar sands, on the Athabaska river, and its tributaries. They are very fine grained sediments, and low in fluxing impurities, No. 190 being exceptionally so, hence they are more refractory than any of the Cretaceous clays from the southern part of the Province.

The samples were too small in size to allow of complete determinations concerning their working and drying qualities, but they appear to be free from the drying defects so common to the western Cretaceous clays.

These clays are of the stoneware type, being exceedingly plastic, and burning to a light-coloured dense body at cone 5, while they retain their shape without softening when fired to much higher temperatures. Their most serious defect is due to the presence of asphaltic carbon, which renders the safe burning of wares made from them a difficult process, Nos. 190 and 191 appear to be free from this impurity, as far as could be told from the small samples, and these clays would be valuable for many purposes.

Up to the present time the possible value of the clays of this part of the Province appears to have been quite overlooked by prospectors and others. The results of the above tests, are, therefore, of interest, since they furnish the first authoritative statement regarding the class of clays to be found in an entirely new area. Given adequate transportation facilities, these results should encourage careful and detailed prospecting for the higher grades of clays in the northern portion of Alberta.

FUSING POINTS OF PYROMETRIC CONES REFERRED TO IN THIS REPORT.

No. of Cone.	Degrees Fahrenheit.	Degrees Centigrade.
010	1742	950
06	1886	1030
03	1994	1090
1	2101	1150
3	2174	1190
5	2246	1230
9	2390	1310
13	2534	1390
14	2570	1410
15	2606	1430
16	2642	1450
17	2678	1470
20	2786	1530
25	2966	1630
26	3002	1650
27	3038	1670

BUILDING AND ORNAMENTAL STONES OF CANADA.

W. A. Parks.

The field work carried on in the eastern Provinces in connexion with this investigation was confined very largely to quarries in actual operation, and to localities already mentioned as possible producers of building or ornamental stone. The slight importance hitherto attained by the building stone industry in the Prairie Provinces makes the above basis of investigation inapplicable. Further, the growing population of the west, and the demand for building material, render necessary a presentation of the subject which will embrace all possible sources of supply. With this end in view, the field work of 1914 was planned to include all the types of stone known to occur within the Province of Manitoba. It is manifest that all recorded exposures could not be visited—the shores of Lake Winnipeg alone would consume a field season, on such a basis; but it was thought advisable to visit all quarries without regard to the object for which they are operated, and to obtain material for testing from each of the geological formations exposed in the Province.

The above basis of investigation having been approved by the director, I left Toronto on June 1, and returned on August 22, having spent two months and three weeks on the work. In this time, the province of Manitoba was covered fairly well, although there are still a few places that it seems advisable to visit: the extension of the Hudson Bay railway should afford an opportunity to examine the rock cuts for a considerably greater distance to the north.

A building stone industry, *per se,* is carried on only at Tyndall, where three companies are actively engaged; but development work is being done by Mr. Joseph Bourgeault on a fine grained Silurian limestone near Broad Valley, on the Inwood branch of the Canadian Northern railway. It is proposed to market this stone under the name "manatobite" for purposes of fine building and even for decoration, as it is said to take a good polish. Other deposits to which attention has been directed as producers of building stone within the narrower meaning of the term are as follows:—

(1.) The sandstones at the base of the Trenton series exposed on the shores and islands of Lake Winnipeg. This stone is for the most part very soft and friable, but it has a remarkable tendency to harden on exposure.

(2.) Sandstones exposed in some of the ravines in the vicinity of Boissevain and Deloraine in the Turtle Mountain district. This stone is of fair quality, and has been used for building purposes.

(3.) Granite on the east side of Lake Winnipeg, particularly at Rabbit point, where claims have been staked. Fairly good reddish granite can be obtained here, but I observed none possessing the requisite features to lift in into the class of monumental granite.

(4.) A deposit of fine grained, bluish and whitish anhydrite, situated to the eastward of Gypsumville, in the northern part of the Province. The deposit appears to be of considerable size, and the stone is of fine appearance; but the application of anhydrite to purposes of decoration has not achieved much success.

The only serious production of building or ornamental stone is confined to the mottled Trenton limestone of Tyndall, already referred to. This stone occurs in heavy layers of uniform quality, although two types are recognized—the blue and the buff. The rock is quarried with facility; it can be easily worked, and its mottled aspect gives a characteristic appearance to the many fine buildings for which it has been used in

Winnipeg. This stone ranks high as a building material, and its fortunate occurrence near the city of Winnipeg makes up in large part for the dearth of high grade stone throughout the Province.

A large amount of stone is quarried in Manitoba for use in macadam and concrete; many of the quarries produce rubble incidentally, and in some cases building blocks are cut from the better layers. The more important of the quarries of this class are as follows:—

Corporation of the City of Winnipeg, Manitoba Quarries, Limited,	Upper Ordovician limestone at Stony mountain.
Manitoba Quarries, Limited, Winnipeg Supply and Fuel Co.,	Silurian limestones at Stonewall.
Manitoba Quarries, Limited,	Silurian limestones at Gunton.
Lake Winnipeg Shipping Co.,	Lower Trenton limestones at Big Island. Lake Winnipeg.
Lake Winnipeg Shipping Co.,	Gneiss on east side of Lake Winnipeg.
Canada Cement Co.,	Devonian limestone at Steeprock on Lake Manitoba.
Moosehorn Lime Co.,	Devonian limestone east of Moosehorn.
Bowman Coal and Supply Co.,	Devonian limestone at Oak Point, Lake Manitoba.

Trenton limestones are exposed at many points along the west shore of Lake Winnipeg. I observed none particularly suited for high grade building stone, but I was much impressed by the possibility of quarrying excellent flagstone.

The Devonian limestones of Lake Manitoba and Lake St. Martin appear to be very thin-bedded, and do not give much promise for the production of building blocks.

Silurian limestones are exposed at the north end of Lake Winnipegosis, at the Grand Rapids of the Saskatchewan, and on Cedar and Cross lakes. Some of this stone is heavily bedded, and would make excellent material for heavy engineering works, as its crushing strength is remarkably high. On the other hand it is hard and of a cavernous nature, which would seriously detract from its value as a building stone.

Many exposures of Devonian limestone occur on the shores and islands of Lake Winnipegosis. Considerable variation is to be observed in different localities both as to the quality of the stone and the nature of the bedding. While no stone eminently adapted to building purposes was observed, there is no doubt that possibilities of production exist at more than one locality.

Hard and reddish mottled Ordovician limestones occur along the line of the Hudson Bay railway, to the northward of Le Pas, and the same type of stone is encountered farther east in the vicinity of Fisher branch. This stone would make good rock-face work of rather unique appearance, but it is too hard and "plucky" for cut stone. Certain of the beds are mottled in red and grey, and possess sufficient hardness and fineness of grain to be susceptible of a good polish. They might be employed as marbles, but I fear that the ever-present tendency to plucking would militate against their use for this purpose.

The basal member of the Cretaceous series of this district—the Dakota sandstone—is exposed on the Red Deer river, and, according to Tyrrell, on the top of Kettle mountain, south of Swan lake. I have been unable to locate any outcrop presenting commercial possibilities.

Strata occur in Turtle mountain, in the south of the province, and include a basal sandstone, which makes a fair quality of building stone. It has been quarried for structural purposes near Boissevain and Deloraine.

ORE DRESSING AND METALLURGICAL DIVISION.

G. C. Mackenzie,

Chief of Division.

I.

During 1914, the staff of this division has been augmented by the appointment of Mr. H. C. Mabee, to the position of chemist.

Messrs. W. B. Timm and C. S. Parsons continued to act in their positions as first and second assistant engineers, respectively.

In May, I returned from Nelson, B.C., where I had resided since October, 1913—while in charge of the zinc investigation for the Mines Branch.

During part of July and August, Mr. B. F. Haanel and I represented the Mines Branch in Hartford, Conn., during an experimental test run of the Johnson electric furnace. We were accompanied by Mr. C. S. Parsons, of this division, and Mr. H. A. Leverin, of the chemical division, who acted as assistants.

In October and November—as a member of the special committee to report on the condition of the iron industry in Canada—I made a lengthy tour of United States iron and steel plants, for the purpose of collecting information with respect to the use of beneficiated iron ores in that country. I also represented the Mines Branch at the annual meeting of the American Iron and Steel Institute, held at Birmingham, Ala., October 28 to 31, 1914.

Construction on the roaster building for the Ore Dressing Laboratories was started in April, and completed in July. Installation of the Wilfley roaster and equipment did not commence until November, owing to the delay of the manufacturers of the furnace in making shipment.

The roaster building consists of a light steel and corrugated iron building, 60 feet long by 20 feet wide, situated about 20 feet from, and at right angles to, the main testing laboratory.

The installations in this building will consist of an 8-foot Wilfley roaster, specially adapted for testing purposes, and a Dwight and Lloyd duplex sintering pan, mounted on trunnions.

The roaster and fans for the ore roaster and sintering pan will be driven by means of a 35-horse power stationary engine.

Additional installations have been made to the equipment of the Ore Dressing Laboratory, consisting of the following:—

One Plumb pneumatic jig, standard size.
One Plumb pneumatic jig, laboratory size.
One small, belt-driven air compressor, for supplying compressed air to the above.
Two James automatic ore jigs, mounted in tandem.
One laboratory apparatus for cyanide agitation tests.
One laboratory apparatus for minerals separation flotation.

The following ores have been tested, and reports made thereon, during the calendar year 1914:—

List of Ores Tested, 1914.

No. of Test.	Ore.	Locality.	Shipper.	Weight.	
				Tons.	lbs.
21	Iron, magnetite	Flower Station, K. & P. R. R., Ontario	Thos. B. Caldwell, Esq., Lanark, Ont	....	280
22	Zinc, calamine	Hudson Bay mine, Deer Creek, West Kootenay, B.C.	P. F. Horton, Esq., Salmo, B.C.	.....	200
23	Iron, magnetite-hematite	Groundhog, Ont., Algoma district	Algoma Central & H.B.R.R. Sault Ste. Marie, Ont.	15	
24	Aluminium, bauxite concentrate	Northern Aluminum Co., Shawenegan Falls, Que.	Northern Aluminum Co., Shawenegan Falls, Que.	...	500
25	Chromium, chromite	Province of Quebec	Geological Survey, Ottawa.	...	200
26	Zinc, zinc blende	Notre Dame Mine Co., of Portneuf, Que	David A. Poe, Esq., Montreal, Que	.....	200
27	Iron, copper, magnetite, chalcopyrite	Vancouver Island, B.C.	R. R. Hedley, Esq., Vancouver, B.C	....	12
28	Phosphorus, iron tailings	Moose mountain, Sellwood, Ont	Moose Mountain, Ltd., Sellwood, Ont	...	5
29	Titanium, ilmenite	Canadian Mining and Exploration Company, Toronto, Ont	W. S. Girard, Esq., Toronto, Ont	.....	200
30	Zinc, zinc blende	New Canadian Metal Co., Riondel, B.C.	S. S. Fowler, Esq., Riondel, B.C.	.....	240
31	Sulphur, iron pyrites	Northern Pyrites Co., North Pines, Ont	Robt. K. Painter, Esq., New York	.....	1,000
32	Zinc-lead-copper, zinc blende, galena, chalcopyrite	Laurentide Mining Co., Notre Dame des Anges, Portneuf co., Que	Stanislas J. Pointon, Esq., Notre Dame des Anges, Que	......	4
33	Iron, magnetic iron sand	Natashkwan, Saguenay co., Que	Mines Branch, Ottawa	35	

TEST NO. 21.

IRON ORE.

A small shipment of 280 pounds of iron ore was received from Mr. T. B. Caldwell, Lanark, Ont. The ore was taken from the stock pile, and was supposed to be an average sample. The deposit is located on lot 22, concession IV, township of Lavant, county of Lanark, Ontario, near Flower station, on the Kingston and Pembroke railway.

The ore consists of a fine grained magnetite, massive, through which is disseminated fine pyrites, hornblende, and calcite gangue.

The ore was crushed to pass through a 100-mesh Sturtevant screen. A head sample was obtained by passing it through a Jones riffled sampler. The remaining material was emptied into a push feeder and fed automatically to the Ullrich four-pole magnetic separator. Wet separation was employed. The current strength on the machine was 4·5 amperes. Six products were obtained: four of concentrate (one from each ring of the machine) and two of tailing. The various products were dried, and samples taken for analysis. From the results obtained the table given below was compiled:—

Head sample analysis—

Insoluble	10·35	per cent.
Iron	58·6	"
Phosphorus	·048	"
Sulphur	·248	"

MAGNETIC CONCENTRATION OF MAGNETITE FROM FLOWER STATION, K. AND P. R. R., ONT.

Product.	Weight.		Percentage of crude ore.	Averaged Analysis.				Combined weight.		Percentage of crude ore.	Calc. Average Analysis.			
	lb.	oz.		% Insoluble.	% Fe.	% P.	% S.	lb.	oz.		% Insoluble.	% Fe.	% P.	% S.
Concentrate from No. 1 Ring.......... ..	86	14	33·05	8·75	64·7	·023	·211	235	3	89·48	9·34	64·2	022	·219
Concentrate from No. 2 Ring...	81	2	30·87	8·67	64·7	·019	212							
Concentrate from No. 3 Ring	60	0	22·83	8·76	64·9	·022	·220							
Concentrate from No. 4 Ring...............	7	3	2·73	28·91	48·1	·042	·369							
Tailing from Rings	12	14	4·90	71·43	9·7	·175	1·00	27	10	10·51	73·39	9·2	·183	1·05
Tailing...	14	12	5·61	75·11	8·7	·190	1·10							
Totals and averages......	262	13	99·99	....	...	.....	.. ...	262	13	99·99	16·07	58·45	·039	·306

The units of crude required per unit of concentrate:—

$$\frac{64{\cdot}2-9{\cdot}2}{58{\cdot}45-9{\cdot}2}=1{\cdot}16$$

The percentage of iron in the crude saved in the concentrate:—

$$\frac{100 \text{ by } 64{\cdot}2}{58{\cdot}45 \text{ by } 1{\cdot}16}=94{\cdot}69 \text{ per cent}$$

Units of tailing made per unit of concentrate 0·16.

The percentage of iron in the crude lost in the tailing:—

$$\frac{100 \text{ by } 9{\cdot}2 \text{ by } 0{\cdot}16}{58{\cdot}45 \text{ by } 1{\cdot}16}=2{\cdot}17 \text{ per cent}$$

Tons of concentrate made per ton of crude=0·895.

Calculations of iron saved from actual weights and analyses:—

$$\frac{235{\cdot}2 \text{ by } 64{\cdot}2 \text{ by } 100}{262{\cdot}8 \text{ by } 58{\cdot}45}=98{\cdot}3 \text{ per cent of the iron in the crude saved in the concentrate}$$

$$\frac{27{\cdot}6 \text{ by } 9{\cdot}2 \text{ by } 100}{262{\cdot}8 \text{ by } 58{\cdot}45}=1{\cdot}7 \text{ per cent of the iron in the crude lost in the tailing.}$$

From the above table it will be noticed that the concentrate from ring No. 4 shows an analysis of insoluble, 28·91 per cent; Fe., 48· per cent; P., ·042 per cent; S., ·369 per cent. By raising this ring, a concentrate could be obtained similar to that from the first three rings. Four important adjustments of the separator on which the results of the test largely depend are the amount of the feed water used; the rate of feed; the distance of the rings from the feed, and the strength of the current on the fields. There was not sufficient ore to make accurate adjustments and obtain the best results. A run of this ore using the Grondal wet magnetic separator would give a comparative test of the efficiency of the two machines.

TEST NO. 22.

ZINC ORE.

A shipment of 200 pounds of ore was received from Mr. P. F. Horton, of the Hudson Bay mine, Salmo, B.C. The ore was taken from the mine workings, 166 feet below the surface.

The ore is a zinc silicate; associated with it are small amounts of, possibly lead silicate and considerable limonite. Analysis of the ore shows it to contain silver and gold in small quantities. The minerals are very closely disseminated, making it very difficult to obtain a separation.

Experiments were conducted to effect a wet concentration by the use of hydraulic classifiers, jigs, and Wilfley tables. A small amount of the fine limonite was washed away, raising the zinc content five per cent; and decreasing the iron content by a similar amount. With this one exception, no concentration was obtainable, due to the closely disseminated character of the mineral constituents of the ore, and to no marked difference in their specific gravity.

Experiments were also conducted to effect a dry separation on the Huff electrostatic separator. The results obtained were not satisfactory.

Electrostatic Separation after Flash Roasting.

Seventy pounds of the ore were taken, and crushed in the laboratory jaw crusher, set at ½-inch opening. The material from the crusher was passed over a 10-mesh Sturtevant screen, the oversize fed to rolls, set at ¼-inch opening, and passed over the

10-mesh screen. The oversize from this second screening was returned to the rolls, set at $\frac{1}{16}$-inch opening, and passed over the 10-mesh screen. The crushed ore through 10-mesh was sampled by passing it through a Jones riffled sampler. During this operation, it was noticed that a concentration had taken place, the oversize on the 10-mesh screen appearing to be a high zinc product, low in iron. This point is of importance in the dressing of the ore.

The crushed ore through 10-mesh was divided into two halves. One portion was given a flash roast, and sized on Sturtevant 16, 20, 30, and 50-mesh screens. The sized products were treated separately on the Huff electrostatic single roll separator.

Head Analysis before Roasting: Zn, 34·16 per cent; Fe, 10·7 per cent; Ag, 1·2 oz.; Insoluble, 24·50 per cent.

HEAD.

Sized Products.	Weight.		Percentage of roasted ore	Analysis.		Contents.	
	lb.	oz.		% Zn.	% Fe.	lb. Zn.	lb. Fe.
– 10 + 16....	9	0	28·51	43·30	8·0	3·897	0·720
– 16 + 20....	3	12	11·88	40·44	9·2	1·516	0·318
– 20 + 30....	4	5	13·66	39·00	10·0	1·683	0·432
– 30 + 50....	3	14	12·28	36·41	12·5	1·411	0·484
– 50	10	10	33·66	29·97	16·2	3·184	1·721
Totals and averages..	31	9	99·99	37·04	11·64	11·691	3·675

Loss in weight by roasting is, approximately, 3 pounds.

Analysis of roasted ore shows an increase of: Zn, 3 per cent; Fe, 1 per cent.

ZINC PRODUCT.

Sized Products.	Weight.		Percentage of roasted ore.	Analysis.		Contents.	
	lb.	oz.		% Zn.	% Fe.	lb. Zn.	lb. Fe.
– 10 + 16....	8	0	88·89	44·06	6·7	3·525	0·536
– 16 + 20....	3	0	80·00	43·06	7·3	1·292	0·219
– 20 + 30....	2	6	55·07	44·26	5·7	1·051	0·135
– 30 + 50....	2	10	67·74	40·44	8·3	1·134	0·218
– 50...	8	14	83·53	29·58	15·8	2·625	1·402
Totals and averages..	24	14	78·81	38·70	10·1	9·627	2·510

Average analysis of zinc product: Zinc..	38·70	per cent.
Iron..	10·1	"
Recovery of zinc values in crude ore...........	82·3	"

IRON PRODUCT.

Sized Products.	Weight.		Percentage of roasted ore.	Analysis.		Contents.	
	lb.	oz.		% Zn.	% Fe.	lb. Zn.	lb. Fe.
– 10 + 16....	1	0	11·11	32·18	16·8	0·322	0·168
– 16 + 20....	0	12	20·00	29·78	19·0	0·233	0·143
– 20 + 30....	1	15	44·93	32·18	16·2	0·623	0·314
– 30 + 50....	1	4	32·26	25·96	22·7	0·325	0·284
– 50.........	1	12	16·47	24·96	22·3	0·437	0·390
Totals and averages..	6	11	21·19	29·01	19·4	1·940	1·299

Average analysis of iron product: Zinc.. ...... 29·01 per cent.
Iron.. ...... 19·4 "
Zinc values of crude ore in iron product.. ...... 16·6 "

Magnetic Separation after Roasting in Reducing Atmosphere.

A portion of the ore through 10-mesh was given a reducing roast, and sized on a Sturtevant 40-mesh screen. The sized products were treated separately on the Ullrich magnetic separator.

Head Analysis before Roasting: Zn., 34.16 per cent; Fe., 10·7 per cent: Ag., 1·2 ounce; Insoluble, 24·56 per cent.

HEAD.

Sized Products.	Weight.		Percentage of roasted ore.	Analysis.		Contents.	
	lb.	oz.		% Zn.	% Fe.	lb. Zn.	lb. Fe.
+ 40	11	8	66·67	39·84	9·4	4·582	1·081
– 40..........	5	12	33·33	32·55	15·2	1·872	0·874
Totals and averages..	17	4	100·00	37·42	11·3	6·454	1·955

ZINC PRODUCT.

Sized Products.	Weight.		Percentage of roasted ore.	Analysis.		Contents.	
	lb.	oz.		% Zn.	% Fe.	lb. Zn.	lb. Fe.
+ 40..........	8	0	69·57	42·45	5·4	3·396	0·432
– 40.........	3	0	52·18	36·20	7·0	1·086	0·210
Totals and averages..	11	0	63·77	40·75	5·8	4·482	0·642

Average analysis of zinc product: Zinc.. ...... 40·75 per cent.
Iron.. ...... 5·8 "
Recovery in zinc values in crude ore.. .... 69·4 "
Iron content of crude ore in zinc product.. .... 32·8 "

IRON PRODUCT.

Sized Products.	Weight.		Percentage of roasted ore.	Analysis.		Contents.	
	lb.	oz.		% Zn.	% Fe.	lb. Zn.	lb. Fe.
+ 40.........	3	8	30·43	33·80	15·8	1·183	0·553
− 40.........	2	12	47·82	26·16	12·4	0·719	0·341
Totals and averages..	6	4	36·23	30·43	14·3	1·902	0·894

Average analysis of iron product: Zinc.. .. .. .. 30·43 per cent.
Iron.. .. .. .. 14·3 "
Zinc content of crude ore in iron product .. .. .. 29·5 "

From the tests conducted on this ore the following conclusions have been arrived at:—

First.—The mineral constituents of the ore being so intimately mixed, and the slight difference in their specific gravity, make it difficult to obtain a wet concentration by jigging and table concentration.

Second.—A concentration is obtained by sizing. It would probably not be advisable to make further separation of the sized products under 30-mesh.

Third.—By roasting, the water is driven off, the limonite is converted, in one case, into hematite, and in the other, into magnetite; hence the head samples of the roasted ores show an increase of approximately 3 per cent in zinc and 1 per cent in iron.

Fourth.—The greater portion of the iron content is contained in the material through 30-mesh. This proportion could probably be increased by roasting the lump ore and crushing afterwards. The particles of iron would not have the tendency to attach themselves to the zinc particles, which takes place in roasting the crushed material.

Fifth.—By careful manipulation and adjustment of the electrostatic separator, the separation of the material through 30-mesh could be improved upon. There was no marked difference in the appearance of the two products, and we were unable to have analyses made, as the tests were conducted to determine the grade of the products and adjust the separator accordingly.

Sixth.—Dry separation on this portion given the reducing roast was not adapted to this ore. A better separation could be obtained by wet magnetic separation. The fine zinc particles were drawn over with the iron. This would not occur to such an extent by wet separation, as was demonstrated by taking a portion of the iron product submerging it in water and pulling out the iron with a horseshoe magnet. A fine zinc product remained, representing approximately 50 per cent of the original portion experimented with in this manner.

Seventh.—A portion of the sized products was taken, submerged in water, and subjected to a violent agitation by a propeller. It was found that the iron content could be reduced to 10 per cent, with a considerable loss in zinc values, in washing off the iron.

Eighth.—A portion of the original shipment remains, on which a test will be made along the following lines, namely: the ore will be calcined to convert the iron into the ferric state, crushed to pass through 10-mesh, violently washed to free the iron from the zinc particles, and the entire product run through the wet magnetic separator.

TEST NO. 5.

Zinc Ore (Calamine) from Hudson Bay Mine, British Columbia.

This is a continuation of test No. 5, the results of which are contained in the Summary Report for 1913.

A portion of the ore was taken and crushed in the laboratory crusher and rolls to pass through a 4-mesh screen. The crushed ore was mixed with 5 per cent of its weight of powdered coal, and roasted to convert the non-magnetic iron oxide into the magnetic oxide. The roasted ore was washed to free the particles of iron and zinc adhering to each other, and the total product run through the Ullrich wet magnetic separator. The results obtained are tabulated below:—

MAGNETIC SEPARATION OF ROASTED ORE.

Current strength: 2 amperes at 60 volts. Distance of rings from feed plates = ¾ inch.

Product.	Weight pounds.	Percentage weight.	Analysis				Contents.				Concentration.			
			per cent.			oz.	pounds.			oz	per cent.			
			Zn.	Fe.	Pb.	Ag.	Zn.	Fe.	Pb.	Ag.	Zn.	Fe.	Pb.	Ag.
Zinc	26 0	78·8	30·45	9·67	4·30	1·06	7·917	2·514	1·118	0138	90·0	57·4	57·9	95·2
Iron	2·8	8·5	17·00	30·66	6·45	0·50	0·476	0·859	0·181	·0007	5·4	19·6	9·4	4·8
Slime loss	4 2	12·7	9·57	23·88	15·05	....	0·402	1·003	0·632	....	4·6	23·0	32·7	
Heads	33 0	100 0	26·65	13·26	5·85	0·88	3·795	4·376	1·931	·0145	100 0	100 0	100 0	100 0

Tons of zinc concentrate per ton of crude=0·788.
Analysis of zinc concentrate=Zinc :—30·45 per cent.
" " Iron:— 9·67 "
" " Lead :— 4·30 "
" " Silver :—1·06 "

Recovery of zinc values of crude in zinc product. =90.0 per cent.
Iron content of crude removed. =42.6 "
Recovery of lead values of crude in zinc product. =57.9 "
Recovery of silver values of crude in zinc product=95.2 "

Test No. 23.

THE CONCENTRATION OF LOW GRADE IRON ORES OF GROUNDHOG, DISTRICT OF ALGOMA, PROVINCE OF ONTARIO.

Introductory.

In the autumn of 1913, application was received by the Director of Mines Branch from Mr. John A. Dresser, manager of the Lands Department of the Algoma Central and Hudson Bay Railway Co., and of the Algoma Eastern Railway Co., asking for a series of tests on a shipment of iron ore from the Company's mining claims situated at Groundhog, in the District of Algoma, in the Province of Ontario.

As this ore represented a distinct class of which there are other similar occurrences in the province, the Mines Branch decided to make a series of tests on a carload of 15 tons of the ore, which was received in November, 1913.

The ore was taken from the surface of the deposit, and consisted of bands of magnetite, hematite, and jasper, the bands ranging from one-half inch in thickness down to a very small fraction of an inch. The shipment showed an average analysis of 35 per cent iron, with only traces of sulphur, phosphorus, and other impurities. It was therefore a question of raising the metallic content, and not one of the elimination of impurities.

On a 35 per cent Fe head analysis, it was found that the ore contained 26·5 per cent Fe as magnetite, and 8·5 per cent Fe as hematite, or 75·8 per cent of the iron content was in the form of magnetite, and 24·2 per cent was in the form of hematite. (This point is worked out in detail in the report.) Theoretically, the best possible extraction by magnetic concentration would be 75·8 of the iron content. This is supposing the magnetite and hematite particles to be free, which is the case with the ore, as these two minerals are in distinct bands. Should the magnetite and hematite particles occur closely associated with each other, it would be possible to obtain, theoretically, a higher extraction than 75·8 per cent of the iron content by magnetic concentration.

The banded structure of this deposit is shown clearly in the cross-section given below.

From this cross-section, drawn from a typical specimen, it will be noted that the magnetite occurs in some cases in bands almost pure, replacing the jasper, in others mixed with the jasper forming the band, and in other cases finely disseminated through the jasper band. The hematite occurs in very thin layers along the parting of the bands. Several other points are also noticeable: namely, coarse crushing will free the larger bands of magnetite from the gangue; but as these magnetite bands contain varying proportions of magnetite, a high concentration cannot be looked for. Coarse crushing will not free the thinner bands of magnetite, nor the hematite along the parting of the bands, as this hematite is, in most cases, firmly attached to one of the walls. All these points, which are demonstrated clearly in the concentration tests following, confirm the fact that, for a good recovery of the iron content in this ore, fine crushing or grinding is necessary. To what stage crushing and grinding should be carried is also demonstrated clearly in the concentration tests following.

Concentration.

The tests conducted were carried on under the following methods of procedure:—

(1) Coarse crushing, followed by dry magnetic concentration of the sized products; dry magnetic concentration of the re-crushed middlings from the coarser sizes; jig concentration of the dry separator middlings from the re-crushed middlings and from the finer sizes and table concentration of the fines.

(2) Coarse crushing, followed by jig concentration of the sized products.

(3) Coarse crushing, followed by fine crushing in rolls; dry magnetic separation followed by jig and table concentration of separator tailings.

The object of the first two tests was to determine whether a commercial and economic product could be obtained, suitable for blast furnace use, without fine grinding, which would necessitate briquetting or sintering. The latter two tests were conducted to determine the maximum recovery, and a comparison of results with the first two tests from which the feasibility of the various methods of concentration can be arrived at.

TEST No. 1.

Preliminary test by coarse crushing, sizing, dry magnetic concentration of sized products, dry magnetic concentration of re-crushed separator middlings from the coarser sizes, and jig concentration of separator middlings from re-crushed middlings, and from the finer sizes.

Approximately, 2 tons of the ore were taken and crushed in the jaw crusher set at 1-inch opening. From the jaw crusher the ore was elevated to the bins, from which it was fed automatically to a set of Sturtevant rolls, set at $\frac{1}{2}$-inch opening. From the rolls it passed through a Vezin sampler set to cut out a sample of $\frac{1}{10}$ of the feed unto a Ferraris screen fitted with 1-inch and $\frac{3}{4}$-inch circular aperture screens. The oversize + 1 inch was re-crushed in the rolls, and passed over the screen until the entire lot, with the exception of the sample, passed through the 1-inch screen. From this operation the sizes — 1 inch + $\frac{3}{4}$ inch and — $\frac{3}{4}$ inch were obtained.

The Ferraris screen was fitted up with $\frac{1}{2}$-inch circular punched and $\frac{1}{4}$-inch straight slot screens and the — $\frac{3}{4}$ inch material was passed over the screens, from which the sizes — $\frac{3}{4}$ inch + $\frac{1}{2}$ inch, — $\frac{1}{2}$ inch + $\frac{1}{4}$ inch and — $\frac{1}{4}$ inch were obtained. The screen frame was fitted up with $\frac{1}{8}$ inch and $\frac{1}{16}$ inch diagonal slot screens, and the — $\frac{1}{4}$ inch material was passed over the screens, from which the sizes— $\frac{1}{4}$ inch + $\frac{1}{8}$ inch, — $\frac{1}{8}$ + $\frac{1}{16}$ inch, and — $\frac{1}{16}$ inch were obtained.

The following screen sizes were made for concentration on the dry magnetic separator:—

Screen.	Weight.	Percentage by weight.	Analysis.
Sizes.	Pounds.	Pounds.	% Fe.
−1″ + $\frac{3}{4}$″	570	19·8	35·05
−$\frac{3}{4}$″ + $\frac{1}{2}$″	772	26·8	33·75
−$\frac{1}{2}$″ + $\frac{1}{4}$″	579	20·1	34·40
−$\frac{1}{4}$″ + $\frac{1}{8}$″	404	14·0	35·00
−$\frac{1}{8}$″ + $\frac{1}{16}$″	272	9·4	34·28
−$\frac{1}{16}$″	284	9·9	34·10
Totals	2,881	100·0	

Analysis of head sample from the Vezin sampler showed it to contain 35·10 per cent Fe.

The following deductions were made from the analyses of the screen sizes to determine the per cent Fe, as magnetite, and the per cent Fe, as hematite:—

Screen Sizes.	Weight.	Analysis.			Contents.		
		% Fe O.		% Fe_2O_3.	Fe O.		Fe_2O_3.
		% Fe.	% FeO.		Fe.	Fe O.	
−1″ + $\frac{3}{4}$″	570	9 0	11·6	37·9	51·300	66·120	216·030
−$\frac{3}{4}$″ + $\frac{1}{2}$″	772	8·8	11·3	35·1	67·936	87·236	270 972
−$\frac{1}{2}$″ + $\frac{1}{4}$″	579	8·6	11·1	36·9	49·794	64·269	213·651
−$\frac{1}{4}$″ + $\frac{1}{8}$″	404	8·6	11·1	37·7	34·744	44·844	152·308
−$\frac{1}{8}$″ + $\frac{1}{16}$″	272	8·2	10·5	37·3	22·304	28·560	101·456
−$\frac{1}{16}$″	284	8·5	10·9	36·6	24·140	30·956	103·944
Totals and averages...	2,881	8·685	11·176	36·736	250·218	321 985	1058·361

The atomic weight of Fe is taken at 55·9.

The atomic weight of O is taken at 16·0.

From the above table the average analysis shows the ore to contain 11·176 per cent Fe O and 36·736 per cent Fe_2O_3. Magnetite has a chemical composition of ($FeO.Fe_2O_3$), hematite has a chemical composition of Fe_2O_3. Therefore the 11·176 per cent FeO will require 24·839 per cent Fe_2O_3 leaving 11·879 per cent Fe_2O_3 as hematite. That is 8·685 per cent Fe + 17·378 per cent Fe = 26·063 per cent Fe occurs as magnetite and 8·311 per cent Fe occurs as hematite, giving a head analysis of 34·374 per cent Fe.

75·82 per cent of the iron content is in the form of magnetite.
24·18 " " " " hematite.

From these deductions it will be seen that the maximum recovery of the iron content by magnetic separation, provided the particles of magnetite are entirely freed, is 75·82 per cent. The finer the ore is ground, the nearer the approach to this maximum recovery of the magnetite is obtained, but the greater the loss of hematite by sliming in the retreatment of the tailings from the magnetite separation. As the magnetite bands vary in their percentage of iron content, it is impossible to make a high grade magnetic product by coarse crushing, without losing a high percentage of the magnetite in the tailings. Fine grinding is necessary to free the hematite from the gangue; although too fine grinding permits a high loss of hematite values in slimes. These are points to be considered in the concentration of this class of ore.

Dry magnetic separation of the sized material, 1″ + $\frac{3}{4}$″—

Current strength on rectifying magnets, 6 amperes at 110 volts.
" " drum " 30 " 110 "
Head sample, Weight, 32 lb. Analysis, 35·05 % Fe.
Concentrates, " 93 lb. " 48·90 % Fe.
Middlings, " 288 lb. " 32·70 % Fe.
Tailings, " 51 lb. " 20·90 % Fe.

Dry magnetic separator of the sized material—¾″ + ½″—

Current strength on rectifying magnets, 6 amperes at 110 volts.
" " drum " 30 " 110 "

Head sample,	Weight, 68 lb.	Analysis, 33·75 % Fe.
Concentrates,	" 160 lb.	" 48·70 % Fe.
Middlings,	" 445 lb.	" 31·15 % Fe.
Tailings,	" 87 lb.	" 21·50 % Fe.

Dry magnetic separation of the sized material, — ½″ + ¼″—

Current strength on rectifying magnets, 6 amperes at 110 volts.
" " drum " 25 " 110 "

Head sample,	Weight, 4 lb.	Analysis, 34·40 % Fe.
Concentrates,	" 119 lb.	" 52·60 % Fe.
Middlings,	" 371 lb.	" 31·75 % Fe.
Tailings,	" 89 lb.	" 20·15 % Fe.

Run No. 2—Products mixed and run over separator—

Current strength on rectifying magnets, 6 amperes at 110 volts.
" " drum " 30 " 110 "

Concentrates,	Weight, 190 lb.	Analysis, 48·00 % Fe.
Middlings,	" 307 lb.	" 27·10 % Fe.
Tailings,	" 55 lb.	" 19·50 % Fe.

Dry magnetic separation of the sized material, — ¼″ + ⅛″—

Current strength on rectifying magnets, 6 amperes at 110 volts.
" " drum " 20 " 110 "

Head sample,	Weight, 4 lb,	Analysis, 35·00 % Fe.
Concentrates,	" 75 lb.	" 54·90 % Fe.
Middlings,	" 238 lb.	" 33·20 % Fe.
Tailings,	" 75 lb.	" 20·90 % Fe.

Run No. 2—Products mixed and re-run over separator—

Current strength on rectifying magnets, 6 amperes at 110 volts.
" " drum " 25 " 110 "

Concentrates,	Weight, 121 lb.	Analysis, 51·40 % Fe.
Middlings,	" 206 lb.	" 28·35 % Fe.
Tailings,	" 43 lb.	" 20·35 % Fe.

Run No. 3—Products mixed and re-run over separator—

Current strength on rectifying magnets, 6 amperes at 110 volts.
" " drum " 30 " 110 "

Concentrates,	Weight, 145 lb.	Analysis, 49·64 % Fe.
Middlings,	" 163 lb.	" 26·86 % Fe.
Tailings,	" 40 lb.	" 20·04 % Fe.

Dry magnetic separation of the sized material—⅛″ + $\frac{1}{16}$″—

Current strength on rectifying magnets, 6 amperes at 110 volts.
" " drum " 15 " 110 "

Head sample,	Weight, 3 lb.	Analysis, 34·28 % Fe.
Concentrates,	" 37 lb.	" 57·22 % Fe.
Middlings,	" 140 lb.	" 37·58 % Fe.
Tailings,	" 86 lb.	" 23·40 % Fe.

Run No. 2.—Products mixed and re-run over separator—

Current strength on rectifying magnets, 6 amperes at 110 volts.
" " drum " 20 " 110 "
Concentrates, Weight, 58 lb. Analysis, 54·70 % Fe.
Middlings, " 122 lb. " 32·60 % Fe.
Tailings, " 56 lb. " 21·00 % Fe.

Run No. 3.—Products mixed and re-run over separator—

Current strength on rectifying magnets, 6 amperes at 110 volts.
" " drum " 25 " 110 "
Concentrates. Weight, 87 lb. Analysis, 52·2 % Fe.
Middlings. " 104 lb. " 28·6 % Fe.
Tailings, " 42 lb. " 19·0 % Fe.

Run No. 4.—Products mixed and re-run over separator—

Current strength on rectifying magnets, 6 amperes at 110 volts.
" " drum " 30 " 110 "
Concentrates. Weight, 94 lb. Analysis, 50·8 % Fe.
Middlings. " 91 lb. " 27·0 % Fe.
Tailings, " 36 lb. " 18·5 % Fe.

Dry magnetic separation of sized material, $-\frac{1}{16}''$—

This size was not run over the separator in conducting the preliminary test, but in the final test the following products were obtained, from which the separation can be figured:—

Current strength on rectifying magnets, 6 amperes at 110 volts.
" " drum " 20 " 110 "
Rate of feed, 1·875 tons per hour.
Head sample, Weight, 67·5 lb. Analysis, 35·67 % Fe.
Concentrates, " 258·0 lb. " 53·13 % Fe.
Tailings, " 326·5 lb. " 23·75 % Fe.

In the operations of the separator, the suction fan in connexion with the machine drew out 97 pounds of dust; the greater proportion of which was deposited in the dust collector.

Dry magnetic separation of re-crushed middlings.

The dry separator middlings $-1'' + \frac{3}{4}''$ and $-\frac{3}{4}'' + \frac{1}{2}''$ were elevated to the ore bins from which they were fed to the rolls set at $\frac{1}{8}''$ opening. From the rolls the re-crushed middlings passed through the Vezin sampler unto the Ferraris screen fitted with $\frac{1}{4}''$ straight slot and $\frac{1}{8}''$ diagonal slot aperture screens. The dry separator middlings $-\frac{1}{2}'' + \frac{1}{4}''$ were elevated to the ore bins from which they were fed to the rolls set at $\frac{1}{16}''$ opening. From the rolls the re-crushed middlings passed through the Vezin sampler unto the Ferraris screen. A sample of 124 pounds was cut out by the Vezin sampler representing the average of the re-crushed middlings. The oversize from the $\frac{1}{4}''$ screen was passed through the rolls until all the material passed through the $\frac{1}{4}''$ screen apertures.

The screen frame was fitted up with $\frac{1}{8}''$ and $\frac{1}{16}''$ diagonal slot aperture screens, and the material passed over the screens from which the sizes $-\frac{1}{4}''+\frac{1}{8}''$, $-\frac{1}{8}''+\frac{1}{16}''$, and $-\frac{1}{16}''$ were obtained.

Head sample. Weight, 124 lb. Analysis, 32·1 % Fe.
Size $-\frac{1}{4}'' + \frac{1}{8}''$. Weight, 390 lb. Analysis, 30·2 Fe.
Size $-\frac{1}{8}'' + \frac{1}{16}''$. Weight, 252 lb. Analysis, 30·7 % Fe.
Size $-\frac{1}{16}''$. Weight, 206 lb. Analysis, 31·5 % Fe.

Dry magnetic separation of re-crushed middlings. Size — $\frac{1}{4}''$ + $\frac{1}{8}''$—

Current strength on rectifying magnets, 6 amperes at 110 volts.
" " drum " 20 " 110 "
Head sample, Weight, ... lb. Analysis, 30·2 % Fe.
Concentrates, " 27 lb. " 52·6 % Fe.
Tailings, " 256 lb. " 34·4 % Fe.
Tailings, " 108 lb. " 21·7 % Fe.

The middlings from this run were re-passed over the separator, with the amperage on drum magnets increased to 30.

Concentrates obtained, 64 lb. Analysis, 44·0 % Fe.
Tailings " 185 lb. " 30·0 % Fe.

Dry magnetic separation of re-crushed middlings. Size — $\frac{1}{8}''$ + $\frac{1}{16}''$—

Current strength on rectifying magnets, 6 amperes at 110 volts.
" " drum " 20 " 110 "
Head sample, Weight, ... lb. Analysis, 30·7 % Fe.
Concentrates, " 46 lb. " 51·3 % Fe.
Middlings, " 108 lb. " 32·5 % Fe.
Tailings, " 92 lb. " 19·5 % Fe.

The middlings from this run were re-passed over the separator, with the amperage on the drum magnets increased to 30.

Concentrates obtained, 35 lb. Analysis, 40·9 % Fe.
Tailings 70 lb. " 29·1 % Fe.

The results obtained from the second concentration of the middlings show that this operation is not practical, so that the products were re-mixed to form the middlings from the first operation.

Dry magnetic separation of re-crushed middlings. Size — $\frac{1}{16}''$—

This size was not run over the separator in conducting the preliminary test, but in the final test the following products were obtained from which the separation can be figured:—

Current strength on rectifying magnets, 5 amperes at 110 volts.
" drum " 23 " 110 "
Head sample, Weight, .. lb. Analysis, 33·43 % Fe.
Concentrates, " 64 lb. " 50·95 % Fe.
Tailings, " 99 lb. " 24·45 % Fe.

JIG CONCENTRATION OF DRY MAGNETIC SEPARATOR MIDDLINGS.

Size, —$\frac{1}{4}$-inch + $\frac{1}{16}$-inch. Weight, 337 pounds—

The separator middlings from this size and from the re-crushed middlings of the coarser sizes, were mixed, sampled, and 40 pounds taken for a jig test on the laboratory Richard's pulsator jig.

Head sample, Weight. .. lb. Analysis, 28·7 % Fe.
Tailings obtained, " 30 lb. " 21·9 % Fe.
Concentrates obtained, " 10 lb. " 51·7 % Fe.

Size, —$\frac{1}{8}$-inch + $\frac{1}{16}$-inch. Weight, 156 lb.—

The separator middlings from this size and from the re-crushed middlings of the coarser sizes were mixed, sampled, and 36 pounds taken for a jig test on the laboratory Richard's pulsator jig.

Head sample, Weight. .. lb. Analysis, 27·3 % Fe.
Concentrates obtained, " 9 lb. " 51·6 % Fe.
Tailings " " 27 lb. " 19·4 % Fe.

Size, —$\frac{1}{16}$-inch. No test work was done on the separator tailings from this size in conducting the preliminary test, but in the final test these tailings were sized, the coarser sizes were jigged, and the fines treated on tables.

JIG CONCENTRATION OF DRY MAGNETIC SEPARATOR TAILINGS.

The separator tailings from the coarser sizes, —1-inch + $\frac{3}{4}$-inch; —$\frac{3}{4}$-inch + $\frac{1}{2}$-inch and —$\frac{1}{2}$-inch + $\frac{1}{4}$ inch were crushed in rolls set at $\frac{1}{16}$-inch opening and sized on Ferraris screens $\frac{1}{8}$-inch and $\frac{1}{16}$-inch. To the sizes obtained, were added the separator tailings, — $\frac{1}{4}$ + $\frac{1}{8}$-inch; — $\frac{1}{8}$-inch + $\frac{1}{16}$-inch and —$\frac{1}{16}$-inch. A portion of the sizes were taken for a jig test on the laboratory type Richard's pulsator jig.

Size, —$\frac{1}{4}$-inch + $\frac{1}{8}$-inch: 100 pounds were taken for a test on the laboratory jig.

Head sample,	Weight,	.. lb.	Analysis,	22·0 % Fe.
Concentrates obtained,	"	27 lb.	"	43·2 % Fe.
Tailings "	"	73 lb.	"	14·3 % Fe.

Size, —$\frac{1}{8}$-inch + $\frac{1}{16}$-inch: 71 pounds were taken for a test on the laboratory jig.

Head sample,	Weight,	.. lb.	Analysis,	20·2 % Fe.
Concentrates obtained,	"	20 lb.	"	36·5 % Fe.
Tailings "	"	51 lb.	"	13·7 % Fe.

Size, —$\frac{1}{16}$-inch: No further test work was done on this size. Analysis of tailing sample, 21·4 % Fe.

Analysis of Dry Magnetic Separator Concentrates, Middlings, and Tailings, from size —$\frac{1}{8}$-inch + $\frac{1}{16}$-inch to determine Magnetite and Hematite Contents.

Analysis of Concentrates: 18·0 % FeO; 52·7 % Fe_2O_3; 50·8 % Fe. The 18·0 % FeO requires 40·0 % Fe_2O_3 to form magnetite. 52·7 % Fe_2O_3 —40·0% Fe_2O_3 = 12·7 % Fe_2O_3 in form hematite. The oxides reduced to their metallic content give 13· % Fe as FeO, and 28·0 % Fe as Fe_2O_2 or 41·9 % Fe as magnetite and 8·9 % Fe as Fe_2O_3 in form of hematite, a total of 41·9 + 8·9 = 58·8 % Fe.

82·5 % of the iron content is in the form of magnetite.
17·5 % " " " hematite.

Analysis of Middlings: 57 % FeO; 32·3 % Fe_2O_3; 27·0 % Fe. The 5·7 % FeO requires 12·7 % Fe_2O_3 to form magnetite. 32·3 % Fe_2O_3 — 12·7 % Fe_2O_3 = 19·6 % Fe_2O_3 in form of hematite.

The oxides reduced to their metallic content give 4·4 % Fe as FeO and 8·9 % Fe as Fe_2O_3 or 13·3 % Fe as magnetite and 13·7 % Fe as Fe_2O_3 in form of hematite a total of 13·3 + 13·7 = 27·0 % Fe.

49·2 % of the iron content is in the form of magnetite.
50·7 % " " " hematite.

Analysis of Tailings: 2·4 % FeO; 23·7 % Fe_2O_3; 18·5 % Fe. The 2·4 % FeO requires 5·3 % Fe_2O_3 to form magnetite. 23·7 % Fe_2O_3 — 5·3 % Fe_2O_3 = 18·4 % Fe_2O_3 in form of hematite. The oxides reduced to their metallic content give 1·9 % Fe as FeO and 3·7 % Fe as Fe_2O_3 or 5·6 % Fe as magnetite and 12·9 % Fe as Fe_2O_3 in form of hematite, a total of 18·5 % Fe.

30·3 % of the iron content is in the form of magnetite.
69·7 % " " " hematite.

Table showing the distribution of magnetite and hematite in the products from the dry magnetic separation of the size, —⅛-inch + 1/16-inch

Concentration Products.	Weight.	Analysis.		Contents.		Percentages.				
		Magnetite FeO. Fe_2O_3.	Hematite Fe_2O_3.	Magnetite.	Hematite.	Magnetite of total Magnetite.	Hematite of total Hematite.	Magnetite of total Iron.	Hematite of total Iron.	Iron of total Iron.
	Pounds.	% Fe.	% Fe.	Pounds.	Pounds.					
Concentrates....	94	41·9	8·9	39·386	8·366	73·6	32·8	49·9	10·6	60·5
Middlings.....	91	13·3	13·7	12·103	12·467	22·6	48·9	15·3	15·8	31·1
Tailings	36	5·6	12·9	2·016	4·644	3·8	18·3	2·5	5·9	8·4
Totals and averages ..	221	24·2	11·5	53·505	25·477	100·0	100·0	67·7	32·3	100·0

Run No. 2.—Final test by coarse crushing, sizing, dry magnetic concentration of the sized material, dry magnetic concentration of re-crushed separator middlings from the coarser sizes, jig concentration of the separator middlings from the re-crushed middlings and from the finer sizes and jig and table concentration of the middlings — 1/16-inch.

A total of 5,608 pounds of the ore were weighed out and crushed in the jaw crusher, set at 1-inch opening. The crushed ore was elevated by a bucket elevator to the ore bins. From the ore bins it was fed by an automatic push feeder through the rolls and Vezin sampler unto the Ferraris screen, fitted up with 1-inch and ¾-inch circular perforated screens. The head sample cut out by the sampler representing one-tenth of the feed was cut down by taking alternate shovelfuls. This sample gave an analysis of 34·00 per cent Fe.

The oversize + 1-inch was elevated to the ore bins, fed to the rolls set at ½-inch opening and passed over the screen until the entire lot passed through the 1-inch screen perforations. From the above operation two sizes were obtained, namely, — 1-inch + ¾-inch and — ¾-inch.

Size — 1″ + ¾″, was elevated to the bin, and run over the Gröndal dry magnetic separator, after first passing through a Vezin sampler, which cut out one-tenth of the feed.

Weight of size — 1″ + ¾″, 1,383 lb.
Weight of sample, 149·5 lb.
Current strength on rectifying magnets, 7 amperes at 110 volts.
" " drum " 26·5 " 110 "
Rate of travel of belt, 339 feet per minute.
Concentrations obtained, Weight, 148·0 lb.
Middlings " " 839·0 "
Tailings " " 207·5 "
In each case a sample of one-tenth was cut out for analysis
Head sample.—Weight, 149·5 lb. Analysis, 34·79 % Fe.
Concentrates sample, Weight, 14·8 lb. Analysis, 45·66% Fe.
Middlings " " 83·0 lb. " 34·89% Fe.
Tailings " " 20·7 lb. " 24·92% Fe.

The separation on this size was not good, so it was decided to crush finer. The concentration products were mixed together, and with the undersize of the ¾-inch screen were elevated and passed over the screen set of ¾-inch and ½-inch circular perforations, giving sizes + ¾″ — ¾″ + ½″ and — ½″. A sample was cut out by the automatic sampler, representing one-tenth of the feed as head sample of the run.

Weight of feed, 5,165 pounds.
Weight of sample, 516·5 pounds.

Sample was cut down to 123 pounds and the remainder added to the run. The oversize + ¾″ was crushed in rolls set at ¼-inch opening and passed over the screen set, until the whole passed through the ¾-inch screen perforations.

Dry magnetic separation of size — ¾″ + ½″.

Weight, 1,378 pounds.
Current strength on rectifying magnets, 4 amperes, 110 volts.
" " drum " 25 " 110 "
Rate of travel of belt, 339 feet per minute.
Results obtained not satisfactory.

Run No. 2.—Concentration products from run No. 1 were mixed and passed over separator again.

Current strength on rectifying magnets, 3·5 amperes, 110 volts.
" " drum " 29 " 110 "
Rate of travel of belt, 339 feet per minute.
Concentrates obtained, 253 lb.
Middlings " 844 lb.
Tailings " 147 lb.
Head sample, 134 lb. Analysis, 34·25 % Fe.
Concentrate sample, 13·5 lb. " 47·05 % Fe.
Middlings " 21·0 lb. " 32·35 % Fe.
Tailings " 4·5 lb. " 23·55 % Fe.

Run No. 3.—Weight, 1,205 pounds—

The concentration products from run No. 2 were mixed and passed again over the separator.

Current strength on rectifying magnets, 6 amperes, 110 volts.
" " drum " 30 " 110 "
Rate of travel of belt, 339 feet per minute.
Time of run, 13 minutes; rate of feed, 2·82 tons per hour.
Concentrates obtained, 250 lb.
Middlings " 898 lb.
Tailings " 57 lb.
Concentrates sample, 12·5 lb. Analysis, 48·85 % Fe.
Middlings " 15·5 lb. " 32·14 % Fe.
Tailing " 18·0 lb. " 22·83 % Fe.

The undersize from the ½-inch screen was screened on the ¼-inch screen (straight slot perforations) and the ⅛-inch and $\frac{1}{16}$-inch screens (diagonal slot perforations). This screening gave the following sizes:—

— ½″ + ¼″, 1,009 pounds.
— ¼″ + ⅛″, 1015 "
— ⅛″ + $\frac{1}{16}$″, 444 "
— $\frac{1}{16}$″, 749 "

Dry magnetic separation of size—½″ + ¼″—

Weight, 1,009 lb.
Current strength on rectifying magnets, 3·5 amperes, 110 volts.
" " drum " 25 " 110 "
Belt travel, 339 feet per minute. Time of run, 30 minutes.
Concentrates obtained, 178 lb.
Middlings " 601 lb.
Tailings " 124 lb.
Head sample, 94 lb. Analysis, 34·20 % Fe.
Concentrate sample, 7 lb. " 48·55 % Fe.
Middling " 8 lb. " 31·10 % Fe.
Tailing " 5 lb. " 24·32 % Fe.

Run No. 2.—Weight, 883 pounds.

The concentration products from run No. 1 were mixed and passed over the separator.

Current strength on rectifying magnets, 6 amperes, 110 volts.
" " drum " 25 " 110 "
Belt travel, 339 feet per minute. Time of run, 10 minutes.
Concentrates obtained, 161 lb.
Middlings " 676 lb.
Tailings " 50 lb.
Concentrate sample, 6 lb. Analysis, 50·64 % Fe.
Middling " 4 lb. " 31·89 % Fe.
Tailing " 5 lb. " 21·44 % Fe.

Dry magnetic separation of size—¾″ + ⅛″—

Weight, 10·15 pounds.
Current strength on rectifying magnets, 5 amperes, 110 volts.
" " drum " 25 " 110 "
Belt travel, 339 feet per minute.
Concentrates obtained, 245 lb.
Middlings " 524 lb.
Tailings " 140 lb.
Head sample, 106 lb. Analysis, 34·28 % Fe.
Concentrate sample, 7·5 lb. " 49·93 % Fe.
Middling " 9·5 lb. " 30·05 % Fe.
Tailing " 8·0 lb. " 21·60 % Fe.

Dry magnetic separation of size—⅛″ + $\frac{1}{16}$″—

Weight, 444 lb.
Current strength on rectifying magnets, 5 amperes, 110 volts.
" " drum " 25 " 110 "
Belt travel, 339 feet per minute. Time of run, 7 minutes.
Concentrates obtained, 258 lb.
Middlings " 184·0 lb.
Tailings " 74·5 lb.
Head sample, 38·5 lb. Analysis, 35·00 % Fe.
Concentrate sample, 6·5 lb. " 50·25 % Fe.
Middlings " 8·0 lb. " 28·88 % Fe.
Tailing " 7·5 lb. " 21·05 % Fe.

Dry magnetic separation of size, $\frac{1}{16}$″—

Weight, 749 lb.
Current strength on rectifying magnets, 6 amperes, 110 volts.
" " drum " 20 " 110 "

Belt travel, 311 feet per minute. Time of run, 12 minutes.
Concentrates obtained, 258 lb.
Tailings “ 326·5 lb.
Dust loss “ 97·5 lb.
Head sample, 67·5 lb. Analysis, 35·67 % Fe.
Concentrate sample, 4·0 lb. “ 53·13 % Fe.
Tailing “ 4·5 lb. “ 23·75 % Fe.

Jig concentrates of dry separator middlings — ¼″ + ⅛″—

Concentrates from No. 1 spout, 132 lb.
“ “ No. 2 spout, 23 lb.
Tailings 354 lb.
Concentrate, No. 1 sample, 4 lb. Analysis, 48·75 % Fe.
Concentrate, “ 2 “ 3 lb. “ 45·22 % Fe.
Tailing 5·5 lb. “ 22·98 % Fe.

Run No. 2.—Products from run No. 1 were mixed and re-run—

Concentrate, 100 lb. Analysis, 53·31 % Fe.
Tailings, 396 lb. “ 24·67 % Fe.

Jig concentration of dry separator middlings, — ⅛″ + 1/16″—

Concentrate from No. 1 spout, 49 lb.
Concentrate “ No. 2 “ 14 lb.
Tailings, 118 lb.
Concentrate No. 1 sample, 3·5 lb. Analysis, 50·94 %.
Concentrate No. 2 sample, 4·5 lb. “ 43·10 %.
Tailings 4·5 lb. “ 20·35 %.

Jig and table concentration of dry separator tailings, —1/16″—

The tailings were sized on 16- and 40-mesh screens.

Size + 16-mesh (0·0445″ aperture)—

Weight, 128·25 lb.
Sample weight, 2 lb. Analysis, 25·25 % Fe.
Jig concentrates obtained, 21 lb. Analysis, 52·25 % Fe.
Jig tailings obtained, 105 lb. Analysis, 19·86 % Fe.

Size — 16 + 40 mesh (— 0·0445″ + 0·0150″)—

Weight, 99 lb.
Sample weight, 1·5 lb. Analysis, 22·41 % Fe.
Wilfley concentrates obtained, 13·5 lb. Analysis, 50·00 % Fe.
Wilfley tailings obtained, 84 lb. Analysis, 17·98 % Fe.

Size — 40 mesh (— 0·0150″ aperture)—

Weight, 29·5 lb.
Sample weight, 1 lb. Analysis, 23·15 % Fe.
Wilfley concentrates obtained, 4·5 lb. Analysis, 54·19 % Fe.
Wilfley tailings obtained, 24 lb. Analysis, 17·86 % Fe.

Dry Separation of re-crushed middlings from sizes — ¾″ + ½″ and ½″ + ¼″—

Size — ¾″ + ½″. Weight, 882 lb.
Size — ½″ + ¼″. “ 672 lb.

Total 1,554 lb.

This material was crushed in rolls to pass the ¼-inch straight slot screen, and sized on ⅛-inch and 1/16-inch diagonal slot screen.

Size — ¼" + ⅛",	8,999 lb.
Size — ⅛" + 1/16",	336·5 lb.
Size — 1/16",	201 lb.
Loss, - - - -	117·5 lb.
Total,	1,554 lb.

Dry magnetic separation of size — ¼" + ⅛"—

Current strength on rectifying magnets,	6 amperes,	110 volts	
" " drum	" 25	"	110 "

Time of run, 10 minutes.

Head sample,	86 lb.	Analysis,	32·57 % Fe.
Concentrates,	106·5 lb.	"	48·20 % Fe.
Middlings,	645·0 lb.	"	30·70 % Fe.
Tailings,	52·0 lb.	"	21·20 % Fe.

Run No. 2.—Products from run No. 1 were mixed and re-run over separator—

Weight, 779 lb.

Concentrates obtained,	97 lb.	Analysis,	48·90 % Fe.
Middlings "	560 lb.	"	31·70 % Fe.
Tailings "	122 lb.	"	22·64 % Fe.

Dry magnetic separation of size — ⅛" + 1/16"—

Current strength on rectifying magnets,	6 amperes,	110 volts.	
" " drum	" 23	"	110 "

Time of run, 3 minutes.

Head sample,	27 lb.	Analysis,	31·50 % Fe.
Concentrates,	75 lb.	"	47·02 % Fe.
Middlings,	192 lb.	"	27·72 % Fe.
Tailings,	35 lb.	"	21·00 % Fe.

Run No. 2.—Products from run No. 1 were mixed and re-run over separator—

Current strength on rectifying magnets,	5 amperes,	110 volts.	
" " drum	" 20	"	110 "

Concentrates obtained,	59 lb.	Analysis,	48·70 % Fe.
Middlings "	204 lb.	"	28·31 % Fe.
Tailings "	27·5 lb.	"	20·54 % Fe.

Dry magnetic separation of size — 1/16"—

Current strength on rectifying magnets,	5 amperes,	110 volts.	
" " drum	" 23	"	110 "

Head sample,	13 lb.	Analysis,	33·43 % Fe.
Concentrates obtained,	64 lb.	"	50·95 % Fe.
Tailings "	99 lb.	"	24·45 % Fe.
Dust loss,	25 lb.		

Jig concentration of dry separator middlings from recrushed middlings. Size — ¼" + ⅛"—

Weight, 553 lb.

Concentrates obtained,	146·5 lb.	Analysis,	50·45 % Fe.
Tailings "	400 lb.	"	24·35 % Fe.
Loss in feeder,	6·5 lb.		

Jig concentration of dry separator middlings from recrushed middlings. Size — $\frac{1}{8}''$ + $\frac{1}{16}''$—

Weight, 200 lb.
Concentrates obtained, 45·5 lb.
Sample, 3·5 lb. Analysis, 48·80 % Fe.
Tailings obtained, 141 lb.
Sample, 2·5 lb. Analysis, 21·24 % Fe.
Loss in feeder, 13·5 lb.

Jig and table concentration of dry magnetic separator middlings from recrushed middlings. Size—$\frac{1}{16}''$—

Weight, 95 lb.
Sized on 16 and 40-mesh screens.
Size + 16 mesh (0·0445″ aperture)—

Weight,	44·5 lb.	Analysis, 26·25 % Fe.
Jig concentrates,	6·25 lb.	" 52·25 % Fe.
Jig tailings,	37·25 lb.	" 19·86 % Fe.

Size — 16 + 40 mesh (— 0·0445 + 0·0150)—

Weight,	40·5 lb.	Analysis, 25·85 % Fe.
Wilfley concentrates,	10 lb.	" 50·00 % Fe.
Wilfley tailings,	29·5 lb.	" 18·00 % Fe.

Size — 40 mesh (— 0·0150″ aperture)—

Weight,	10 lb.	Analysis, 26·46 % Fe.
Wilfley concentrates,	2·25 lb.	" 54·19 % Fe.
Wilfley tailings,	7·00 lb.	" 17·86 % Fe.

The following flow sheet and graphic illustration show the methods of procedure and the results obtained from the run.

Run No. 3—Coarse crushing, followed by jig concentration of the sized products. A portion of the ore was taken, crushed in the jaw crusher set at 1-inch opening, elevated to the ore bin from which it was fed to the rolls set at $\frac{1}{2}$-inch opening. From the rolls it passed through the Vezin sampler unto the Ferraris screen fitted with 1-inch and $\frac{3}{4}$-inch circular perforated screens. The oversize was returned to the circuit until the entire lot passed the 1-inch screen.

The — $\frac{3}{4}''$ size from the above operations was returned to the elevator and passed over the screen fitted with $\frac{1}{2}$-inch screen (circular perforations) and $\frac{1}{4}$-inch screen (straight slot perforations).

The — $\frac{1}{4}''$ size was returned to the elevator and passed over the screen fitted with $\frac{1}{8}$-inch and $\frac{1}{16}$-inch diagonal slot screens.

The following screen sizes were obtained:—

Size.	Weight.	Analysis.
	lb.	Per cent Fe.
— 1 + $\frac{3}{4}$	2,613	32·04
— $\frac{3}{4}$ + $\frac{1}{2}$	1,739	35·07
— $\frac{1}{2}$ + $\frac{1}{4}$	1,218	35·71
— $\frac{1}{4}$ + $\frac{1}{8}$	1,105	36·06
— $\frac{1}{8}$ + $\frac{1}{16}$	853	35·72
— $\frac{1}{16}$	912	35·02

I

FLOW SHEET

BANDED IRON ORE

DRY MAGNETIC SEPARATION, JIG AND TABLE CONCENTRATION

TEST No 23

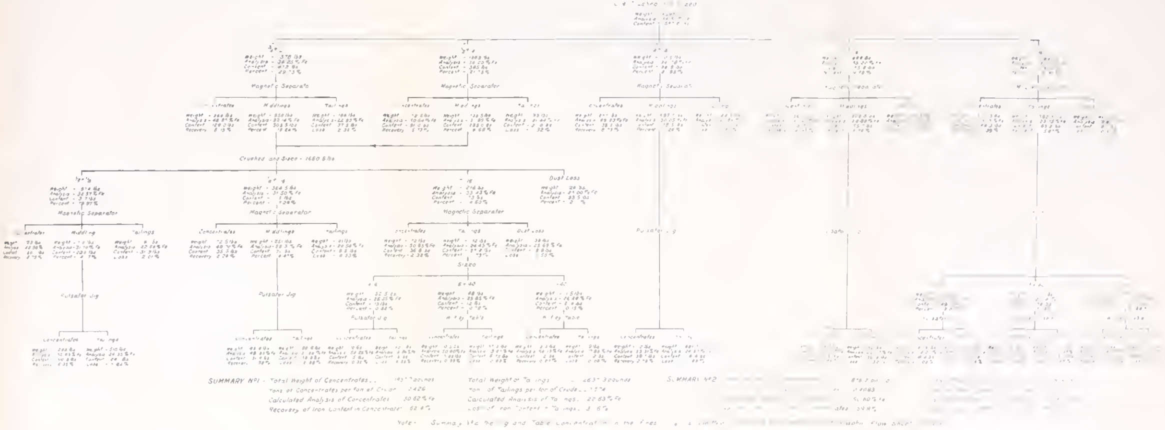
Magnetic Separator
Concentrates
Middlings
Tailings
Crushed and Sized - 1660.5 lbs
Dust Loss
Pulsator Jig
Sized
Wilfley Table
SUMMARY Nº1
Total Weight of Concentrates
Tons of Concentrates per ton of Crude
Calculated Analysis of Concentrates
Recovery of Iron Content in Concentrates
Total Weight of Tailings
Tons of Tailings per ton of Crude
Calculated Analysis of Tailings
Loss of Iron Content in Tailings
SUMMARY Nº2

Fig 2

5

[illegible]

[illegible]

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[illegible]

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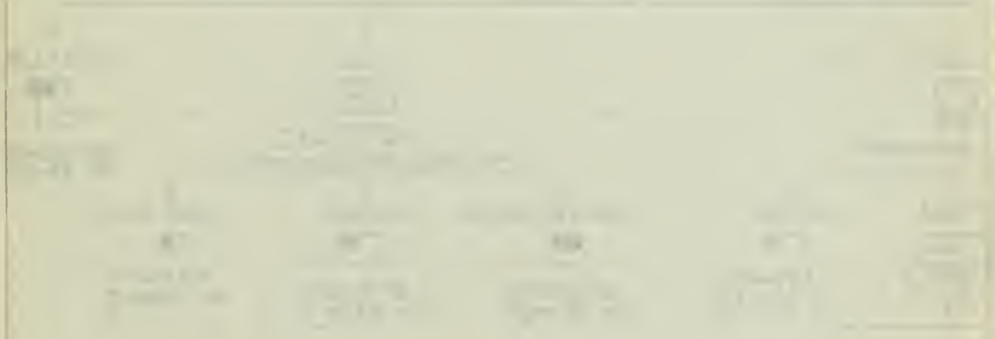

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2

GRAPHIC METHOD OF ILLUSTRATING RECOVERY OF IRON CONTENT

BANDED IRON ORE

DRY MAGNETIC SEPARATION AND JIG CONCENTRATION OF SEPARATOR MIDDLINGS

TEST NO 23

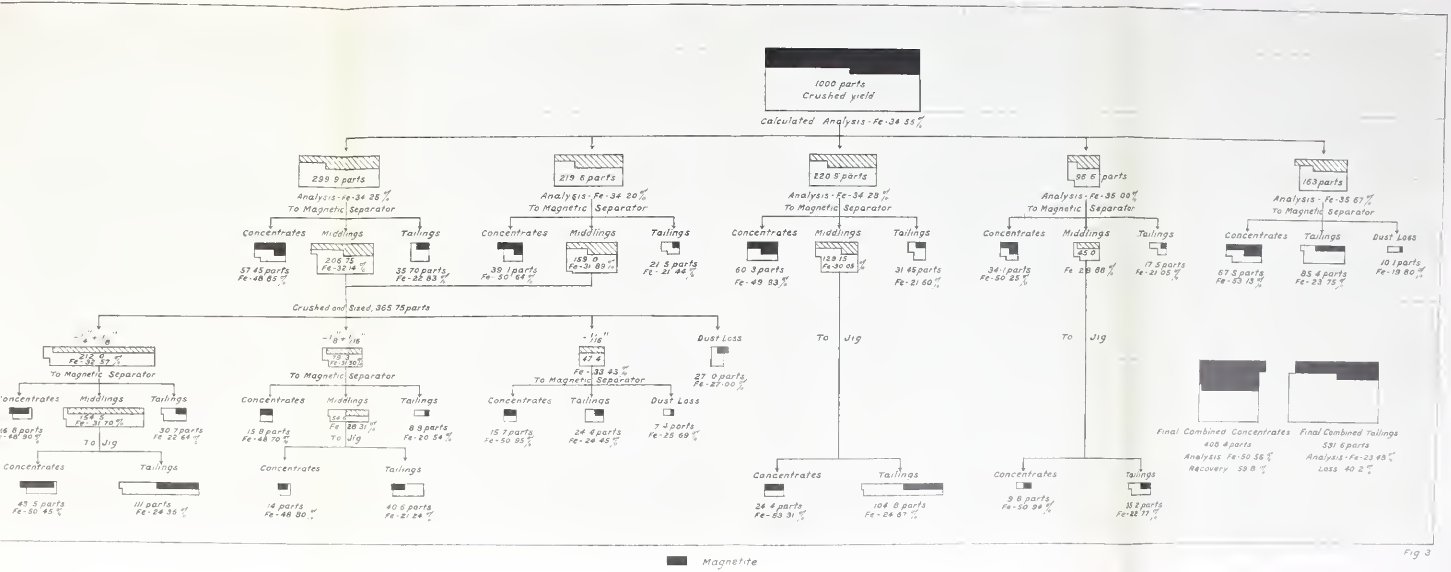
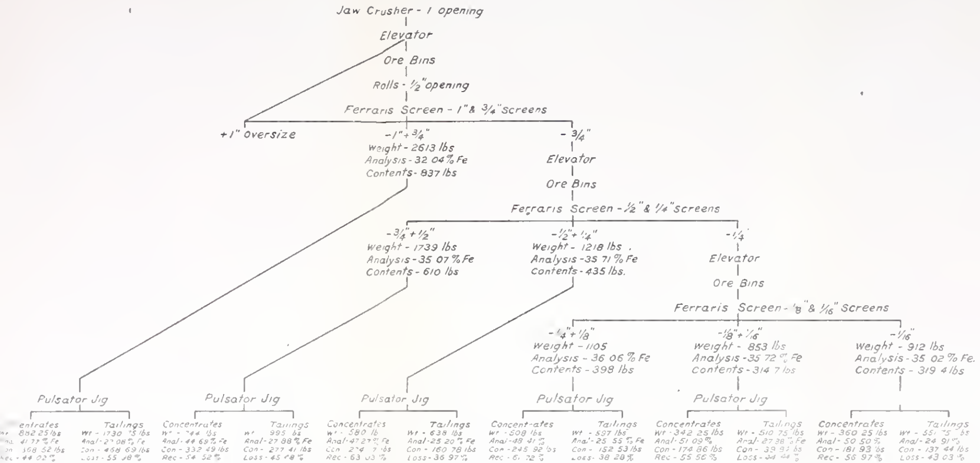


Fig 3

3



Averaged Analysis of Concentration Products
Crude Ore ____ 34 53 % Fe
Concentrates ___ 46 12 % Fe
Tailings _____ 26 61 % Fe

Total Recovery of Iron Content ____ 54 14 %
Total Loss of Iron Content ________ 45 86 %
Tons of Concentrate per ton of Crude __ 0 405
Tons of Crude per ton of Concentrate __ 2 47

Fig. 1.—Flow sheet, banded iron ore, jig concentration tests

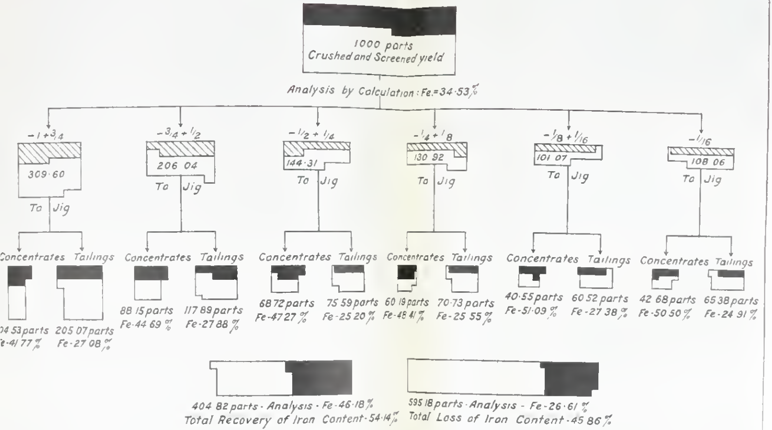
4

GRAPHIC METHOD OF ILLUSTRATING RECOVERY OF IRON CONTENT

BANDED IRON ORE

JIG CONCENTRATION

TEST NO 23



■ Magnetite

Fig 5

Size — 1″ + ¾″. Weight, 2,613 lb.
Weight to jig, 454 lb.
Concentrate obtained, 118 lb. Analysis, 41·77 % Fe.
Tailings, " 336 lb. " 27·08 % Fe.

Size — ¾″ + ½″. Weight, 1,739 lb.
Weight to jig, 528 lb.
Concentrate obtained, 223 lb. Analysis, 44·69 % Fe.
Tailings, " 305 lb. " 27·88 % Fe.

Size — ½″ + ¼″. Weight, 1218 lb.
Weight to jig, 1091 lb.
Concentrate obtained, 531 lb. Analysis, 47·27 % Fe.
Tailings " 560 lb. " 25·20 % Fe.

Size — ¼″ + ⅛″. Weight, 1105 lb.
Weight to jig, 1035 lb.
Concentrate obtained, 504 lb. Analysis, 48·41 % Fe.
Tailings " 531 lb. " 25·55 % Fe.

Size — ⅛″ + 1/16. Weight, 853 lb.
Weight to jig 725 lb.
Concentrates obtained, 297 lb. Analysis, 51·09 % Fe.
Tailings " 428 lb. " 27·38 % Fe.

Size — 1/16″. Weight, 912 lb.
Weight to jig, 790 lb.
Concentrates obtained, 312 lb. Analysis, 50·50 % Fe.
Tailings " 378 lb. " 24·91 % Fe.

A flow sheet showing the methods of procedure and the results of the test, and a graphic illustration showing the recovery of iron content, follows.

Run No. 4.—Coarse crushing, followed by fine crushing in rolls, dry magnetic separation followed by jig and table concentration of separator tailings.

A portion of the ore was taken and crushed in the jaw crusher and rolls to pass through the 1/16-inch slot screen.

Weight to dry magnetic separator, 2,530 lb.
Current strength on rectifying magnets, 6 amperes, 105 volts.
" " " drum " 20 " 105 "
Belt travel, 339 feet per minute.
Concentrates obtained, 969·5 lb. Analysis, 53·95 % Fe.
Tailings " 1428·5 lb. " 24·78 % Fe.
Dust loss, 132·0 lb. " 19·85 % Fe.

The tailings were screened on the 16- and 40-mesh screens, giving the following sizes:—

Size.	Aperture.	Weight.	Analysis.
		lb.	Per cent Fe.
+ 16.......	+ ·0445″	875	25·05
− 16 + 40........	− ·0445″ + ·0150″	368·5	24·50
− 40	− ·0150″	185	24·04

Size + 16 mesh was treated on the Richard's jig—

Concentrates obtained, 168·5 lb. Analysis, 50·72 % Fe.
Tailings " 706·5 lb. " 18·93 % Fe.

Size — 16 + 40 was treated on the Richard's jig—

Concentrates obtained, 69·25 lb. Analysis, 51·40 % Fe.
Tailings " 299·25 lb. " 18·27 % Fe.

Size — 40 was run over the Wilfley table—

Concentrates obtained, 31 lb. Analysis, 54·23 % Fe.
Tailings " 154 lb. " 17·93 % Fe.

A flow sheet showing the methods of procedure and the results obtained, and a graphic illustration showing the recovery of the iron content, follows.

Run No. 5.—Preliminary test by fine grinding in conical mill, followed by magnetic concentration in Gröndal double drum wet separator.

The concentration products from the jig test were mixed together, elevated to the ore bin, passed through a Vezin sampler, through a chute to the conical mill. The discharge end of the mill is connected with the Gröndal double drum wet separator by a step launder. A flood automatic sampler passes through the feed to the separator and cuts out a portion of the feed every 15 minutes. The current strength carried on the separator drum was 6 amperes, 110 volts. The concentrates from the separator were pumped by a 1-inch centrifugal pump to a settling tank. Samples of the concentrates and tailings were obtained by flood automatic samplers which cut out a sample every 15 minutes from the pump discharges.

The samples from the flood automatic samplers gave the following analysis:—

Feed to separator, 34·20 % Fe.
Concentrates, 63·41 % Fe.
Tailings, 20·99 % Fe.

The tailing analysis also showed that 1·06 % Fe existed as FeO and 19·93 % Fe as Fe_2O_3. The 1·06 % Fe requires 2·10 % Fe as Fe_2O_3 to form magnetite. 19·93 % — 2·10 % = 17·83 % Fe as hematite, i.e., had the total magnetite been recovered in the concentration of the grade 63·41 % Fe, the tailings would have shown 17·83 % Fe entirely as hematite. The tailings from the settling tank were dried and sampled. This sample gave an analysis of 21·73 % Fe showing that some specular hematite was lost as slimes in the taking of the sample.

Weight of concentrates 1,011 pounds.

From the amount of concentrates and the analysis of the feed and concentration products, the weight of feed and the weight of tailings are arrived at.

Heads, Weight X lb. Analysis, 34·20 % Fe.
Concentrates, Weight, 1,011 lb. Analysis, 63·41 % Fe.
Tailings, Weight, (X — 1,011) lb. Analysis, 21·73 % Fe.
34·20 X = (63·41 × 1011) + 21·73 (X — 1011).
3420 X = 6410751 + 2173 × 2196903.
1247 X = 4213848 + 2173 X = 2196903.
X = 3379 lb.
X — 1011 = 2368 lb.
Heads, 3379 × 34·20 = 1155·62 lb. metallic iron.
Concentrates, 1011 × 63·41 = 641·08 " "
Tailings, 2368 × 21·73 = 514·54 "

Recovery of iron content in concentrates—

$$\frac{641\cdot08 \times 100}{1155\cdot62} = 55\cdot48\ \%.$$

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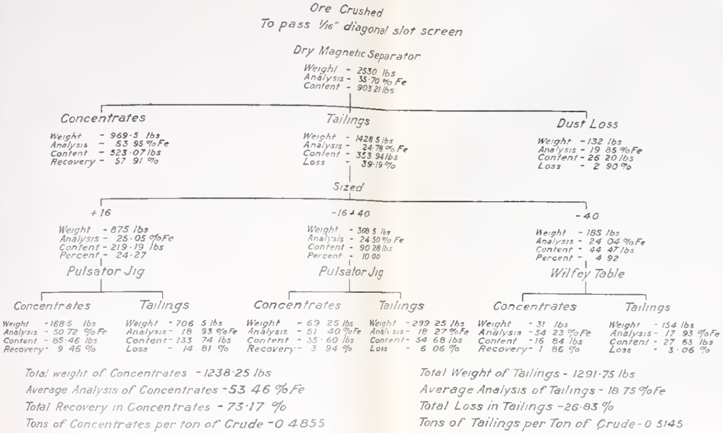


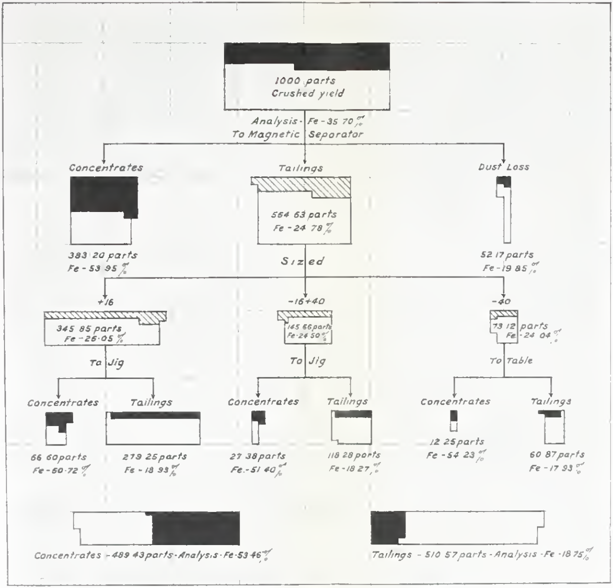
Fig 6 —Flow sheet, banded iron ore, fine crushing Dry magnetic separation jig and table concentration tests Test No 23

GRAPHIC METHOD OF ILLUSTRATING RECOVERY OF IRON CONTENT

BANDED IRON ORE

FINE CRUSHING, DRY MAGNETIC SEPARATION, JIG AND TABLE CONCENTRATION

TEST No. 23



■ Magnetite

Fig 7

Loss of iron content in tailings—

$$\frac{511{\cdot}54 \times 100}{1155{\cdot}62} = 44{\cdot}52\ \%.$$

Wet Magnetic Separation of Gröndal Tailings.

A portion of the tailings from the Gröndal wet magnetic separator was run through the Ullrich magnetic separator to obtain a separation of the hematite from the gangue. It was found that the gangue was nearly as magnetic as the hematite, as is shown by the analysis obtained:—

Head sample, 21·85 per cent
Concentrates, 25·20 "
Tailings, 19·72 "

Run No. 6.—Final test by coarse crushing, fine grinding, wet magnetic separation and table concentration of separator tailings.

Some 3,962 pounds of the ore were taken, crushed in the jaw crusher set at 1-inch opening and elevated to the ore bins. From the bins the crushed ore was fed by a push feeder to elevator No. 2, which discharged it to a Vezin sampler. From the sampler the ore passed through a chute to the conical mill. After fine grinding in the conical mill, it flowed through a step launder to the wet magnetic separator. A head sample was cut out by an automatic flood sampler which cut through the feed every fifteen minutes. From the separator the concentrates were conveyed to a 1-inch centrifugal pump, and discharged into a settling tank; the tailings were conveyed to a 2-inch centrifugal pump, and discharged into a settling tank. Samples of the concentrates and tailings were taken by automatic flood samplers which cut out a portion every fifteen minutes from the discharge of the pumps.

Analyses of samples—

Head sample, Fe —35·89 %
Concentrates, Fe —64·01 %
FeO —27·31 % or 21·24 % Fe.
Fe_2O_3 —61·10 % or 42·77 % Fe.
SiO —10·58 %
S — 0·004%
P — 0·025%
Mn. — 0·014%

Tailings, Fe — 22·63 per cent.

Clean up of conical mill, Fe — 43·47 per cent.

Screen analyses of conical mill discharge—

Size.	Aperture.	Weight.	Percentages.	Analysis.
		grms	p.c.	
+ 20	+ 0·025	1·5	0·065	46·46
− 20 + 30	+ 0·0166	3·4	0·148	33·00
− 30 + 40	+ 0·0125	10·0	0·433	28·00
− 40 + 50	+ 0·01	15·5	0·673	24·66
− 50 + 60	+ 0·0083	41·5	1·802	26·62
− 60 + 70	+ 0·0071	57·5	2·497	27 62
− 70 + 80	+ 0·0062	36·0	1·563	28·61
− 80 + 90	+ 0·0055	70·5	3·061	33 60
− 90 + 100	+ 0·005	23·5	1·020	33·50
− 100 + 120	+ 0·0042	105·5	4·581	39·18
− 120 + 150	+ 0·0032	127·5	5·536	41·77
− 150 + 200	+ 0 0025	223·0	9·683	42·07
− 200	− 0·0025	1587·6	68 936	35·89
Totals		2303·0 grms.	99·998	36·19

NOTE.—Size + 20-mesh probably contained small fragments of the iron balls, hence the high analysis.

Time of run—

Test started at 11.30 a.m.
Bin empty at 3.30 p.m.
Mill run to 4.30 p.m.

Ball consumption for 8,044 pounds of ore—

Weight.	Before crushing.	After crushing.	Loss.
	lb.	lb.	lb.
4″	1,500	1,477	23
3″	500	487	13
2″	250	247	3
Totals	2,250	2,211	39

Power consumption on magnets—

Current strength on magnets—

Drum No. 1, 5 to 6 amperes, 100 to 110 volts.
Drum No. 2, 5 to 6 amperes, 100 to 110 volts.

Meter reading—

11.30 a.m., 163·5 k.w.h.
3.30 p.m., 168·0 k.w.h.
4.30 p.m., 169·0 k.w.h.

Water consumption—

Ball mill—	Time.	Reading.
Start	11.30 a.m.	243 cub. ft.
Bin empty	3.30 p.m.	356 "
"	4.00 p.m.	370 "
"	4.15 p.m.	380 "
"	4.25 p.m.	391 "
Stop	4.30 p.m.	396 "
Grondal separator—		
Start	11.30 a.m.	4,315 cub. ft.
Bin empty	3.30 p.m.	6,000 "
Stop mill	4.30 p.m.	6,400 "

Summary of Test—Calculations from weights and percentages obtained—

Weight of ore first taken, 3,962 lb.
Weight of concentrates, 1,263 lb.

Weight of ore left in ball mill, 243 lb. Approximately this amount was left in from preliminary run, so does not figure in calculations on this run.

Separator feed, X lb. Analysis, 35·89 per cent Fe.
Concentrates, 1263 lb. " 64·01 per cent Fe.
Tailings, (X — 1263 lb.) " 22·63 per cent Fe.

$35{\cdot}89\,X = (64{\cdot}01 \times 1263) + 22{\cdot}63\,(X - 1263).$

$3589\,X = 8084463 + 2263\,X - 2858169.$

$1326\,X = 5226294.$

$X = 3941$ lb.

$X - 1263 = 2678$ lb.

Separator feed, 3941 x 35·89 = 1414·43 lb. metallic iron.
Concentrates, 1263 x 64·01 = 808·44 lb. "
Tailings, 2678 x 22·63 = 606·03 lb.

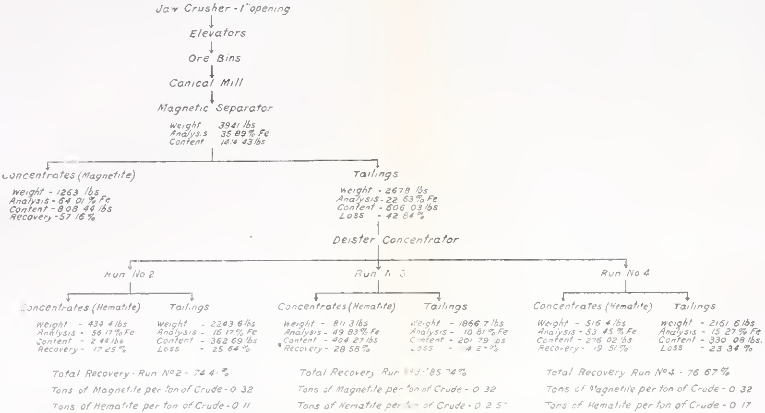
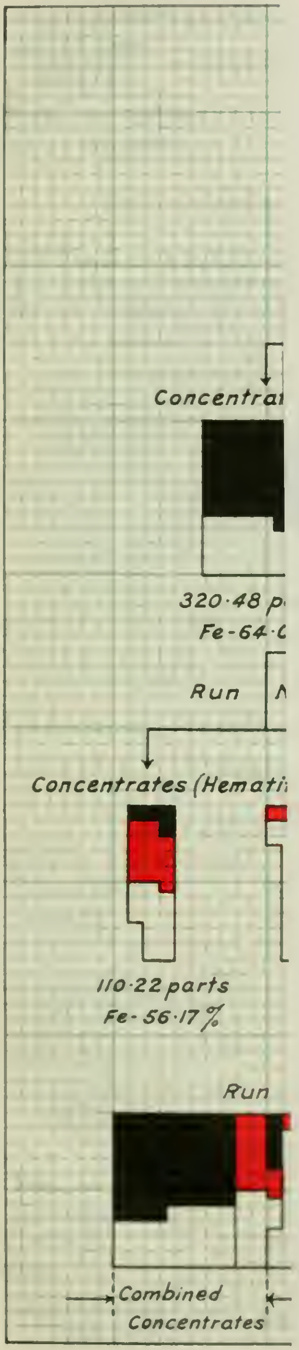


Fig. 8.—Flow sheet, banded iron ore. Wet magnetic separation and table concentration tests. Test No. 23.


Concentrat
320·48 p
Fe-64·C
Run
N
Concentrates (Hemati
110·22 parts
Fe-56·17%
Run
Combined
Concentrates

GRAPHIC METHOD OF ILLUSTRATING RECOVERY OF IRON CONTENT

BANDED IRON ORE

WET MAGNETIC SEPARATION AND TABLE CONCENTRATION

TEST NO 23

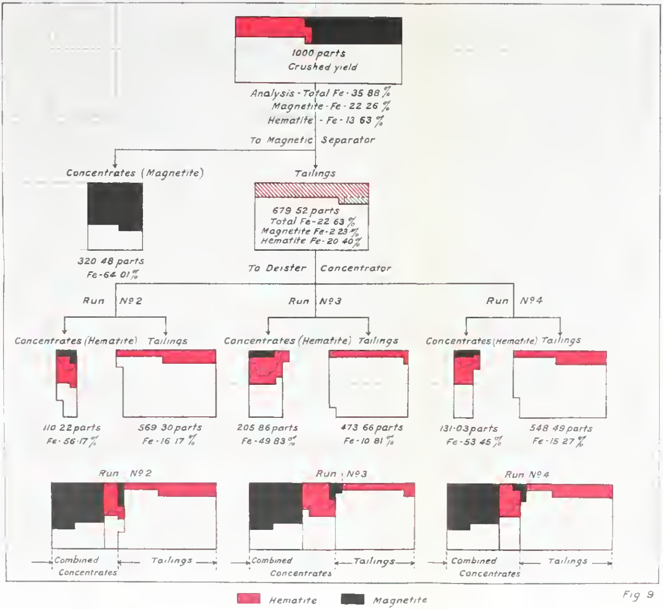


Fig 9

Recovery of iron content in concentrates—

$$\frac{808\cdot 44 \times 100}{1414\cdot 43} = 57\cdot 16 \text{ per cent.}$$

Loss of iron content in tailings—

$$\frac{606\ 03 \times 100}{1414\cdot 43} = 42\cdot 84 \text{ per cent.}$$

From the analysis of the concentrate given above it is found that the total iron content is magnetite.

Table Concentration of Wet Magnetic Separator Tailings.

Run No. 1.—A portion of the tailings from the wet magnetic separator was run over the Deister concentrator to determine what kind of a separation could be made and also to determine the table adjustments necessary for this class of material. No weights were taken, but samples were taken of the products for analysis.

Feed to concentrator,	22·63 per cent Fe.
Concentrates,	60·20 per cent Fe.
Middlings,	43·39 per cent Fe.
Tailings,	14·18 per cent Fe.

Run No. 2.—The table was adjusted and fitted to make only two products.

Feed to concentrator,	413 lb.	Analysis,	22·63 per cent Fe.
Concentrates,	67 lb.	"	56·17 per cent Fe.
Tailings,	346 lb.	"	16·27 per cent Fe.

Recovery of iron content in concentrates—

$$\frac{67 \times 56\cdot 17 \times 100}{413 \times 22\cdot 63} = 40\cdot 3 \text{ per cent.}$$

Loss of iron content in tailings—

$$\frac{346 \times 16\cdot 17 \times 100}{413 \times 22\cdot 63} = 59\cdot 8 \text{ per cent.}$$

Run No. 3.—Further adjustments made to table.

Feed to concentrator,	101·5 lb.	Analysis.	22·63 per cent Fe.
Concentrates,	30·75 lb.	"	49·83 per cent Fe.
Tailings,	70·75 lb.	"	10·81 per cent Fe.

Recovery of iron content in concentrates—

$$\frac{30\cdot 75 \times 49\cdot 83 \times 100}{101\cdot 50 \times 22\cdot 63} = 66\cdot 7 \text{ per cent.}$$

Loss of iron content in tailings—

$$\frac{70\cdot 75 \times 10\cdot 81 \times 100}{101\cdot 50 \times 22\cdot 63} = 33\cdot 3 \text{ per cent.}$$

Run No. 4.—Further adjustment made to table.

Feed to concentrator,	258·00 lb.	Analysis,	22·63 per cent Fe.
Concentrates,	49·75 lb.	"	53·45 per cent Fe.
Tailings,	208·25 lb.	"	15·27 per cent Fe.

Recovery of iron content in concentrates—

$$\frac{49\cdot 75 \times 53\cdot 45 \times 100}{258 \times 22\cdot 63} = 45\cdot 55 \text{ per cent.}$$

Loss of iron content in tailings—

$$\frac{208\cdot25 \times 15\cdot27 \times 100}{258 \times 22\cdot63} = 54\cdot45 \text{ per cent.}$$

The concentration tests on the Deister concentrator show that the higher the grade of concentrate the greater the loss of iron content in the tailing, and vice versa. Even in this finely divided state there remain particles of mixed hematite and gangue.

Summary of results—

Recovery of iron content in separator concentrates, 57·16 per cent.
Loss of iron content in separator tailings, 42·84 per cent.
Recovery of iron content in Deister concentrates, Run No. 2—
42·84 × 40·3 = 17·26 per cent.
i.e., 57·16 per cent of the iron content is recovered as magnetite.
17·26 “ “ “ “ “ hematite.
74·42 “ “ “ “ total recovery.

Recovery of iron content in Deister concentrate, Run No. 3—
42·84 × 66·7 = 28·57 per cent.
i.e., 57·16 per cent of the iron content is recovered as magnetite.
28·57 “ “ “ “ “ hematite.
85·73 “ “ “ “ total recovery.

Recovery of iron content in Deister concentrate, Run No. 4—
42·84 × 45·55 = 19·51 per cent.
i.e., 57·16 per cent of the iron content is recovered as magnetite.
19·51 “ “ “ “ “ hematite.
76·67 “ “ “ “ total recovery.

Tons of magnetite (wet separator concentrate) per ton of crude—

$$\frac{0\cdot6315}{1\cdot9705} = \cdot32 \text{ of grade } 64\cdot01 \text{ per cent Fe.}$$

Tons of crude per ton of concentrate (magnetite)—

$$\frac{1\cdot00}{0\cdot32} = 3\cdot125$$

Tons of hematite (Deister concentrates, Run No. 2) per ton of crude—

$$\frac{\cdot0335}{\cdot2065} \times \frac{1\cdot3990}{1\cdot9705} = \cdot11 \text{ of grade } 56\cdot17 \text{ per cent Fe.}$$

Tons of crude per ton of table concentrates (hematite)—

$$\frac{1\cdot00}{0\cdot11} = 9\cdot1$$

Tons of hematite (Deister concentrates, Run No. 3) per ton of crude—

$$\frac{\cdot015375}{\cdot050750} \times \frac{1\cdot3990}{1\cdot9705} = \cdot2157 \text{ of grade } 49\cdot83 \text{ per cent Fe.}$$

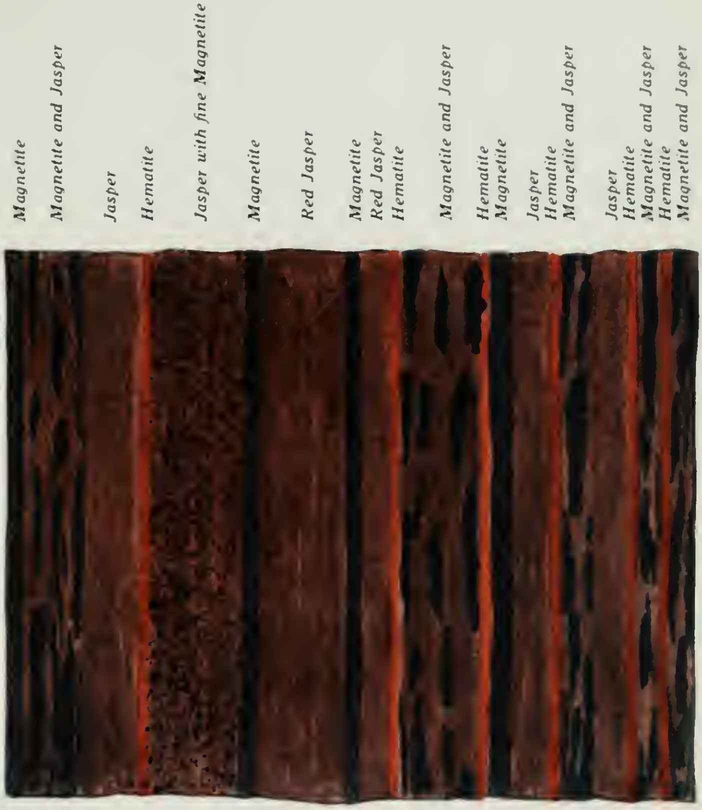


Fig. 10. *Ideal section of banded iron ore, from Groundhog mine, Timiskaming district, Ont.*

Tons of crude per ton of table concentrates (hematite)—

$$\frac{1 \cdot 0000}{0 \cdot 2157} = 4 \cdot 6$$

Tons of hematite (Deister concentrates, Run No. 4) per ton of crude—

$$\frac{\cdot 024875}{\cdot 104125} \times \frac{1 \cdot 3990}{1 \cdot 9705} = \cdot 17 \text{ of grade } 53 \cdot 45 \text{ per cent Fe.}$$

Tons of crude per ton of table concentrates (hematite)—

$$\frac{1 \cdot 00}{0 \cdot 17} = 5 \cdot 9$$

A point of particular importance is the varying percentage of magnetite and hematite in the ore. The ore taken for run No. 1 showed an analysis of: Total Fe, 34·374 per cent; Fe as magnetite, 26·063 per cent; Fe as hematite, 8·311 per cent. The ore taken for run No. 6 showed an analysis of: Total Fe, 35·89 per cent; Fe as magnetite, 22·26 per cent; Fe as hematite, 13·63 per cent.

Had the former grade been taken for run No. 6, the test would have shown a marked increase in the recovery of the iron content as magnetite. The recovery shown in run No. 6, as 57·16 per cent, would have been 69·86 per cent, an increase of 12·70 per cent. The recovery of the iron content by table concentration would have been as follows:—

Run No. 2.—12·09 per cent.
Run No. 3.—20·10 "
Run No. 4.—13·71 "

A total recovery of—

Run No. 2.—As	magnetite,	69·86	per cent.
"	hematite,	12·09	"
	Total,	81·95	"
Run No. 3.—As	magnetite,	69·86	per cent.
"	hematite,	20·10	"
	Total,	89·96	"
Run No. 4.—As	magnetite,	69·86	per cent.
"	hematite,	13·71	"
	Total,	83·57	"

The following flow sheet, and graphic illustration, show the methods of procedure, and the results obtained from the run.

TEST NO. 24.

A shipment of three boxes containing 600 pounds of bauxite concentrate was received from the Northern Aluminum Company, Limited, Shawenegan Falls, Quebec.

The head sample of the feed to the machines showed it to contain 0·15 per cent metallic iron. It was supposed that the iron content was in the ferric state, and consisted of fine particles through the concentrate. The object of the test was to lower the iron content thus making a higher grade product for the manufacture of aluminum wire.

Tests were conducted on portions of concentrate on the following machines:—

The Ullrich magnetic separator.
The Huff electrostatic separator.
The Gröndal magnetic separator.

Run No. 1.—Ullrich magnetic separator—

Feed, dry.
Distance of feed from rings, 1 inch.
Current strength, 10 amperes at 110 volts.
Concentrate analysis, 0·14 per cent Fe.

Run No. 2.—Ullrich magnetic separator—

Feed, wet.
Distance of feed from rings, 1 inch.
Current strength, 10 amperes at 110 volts.
Concentrate analysis, 0·13 per cent Fe.

Run No. 3.—Ullrich magnetic separator—

Feed, wet.
Distance of feed from rings, ½ inch.
Current strength, 10 amperes at 110 volts.
Concentrate analysis, 0·13 per cent Fe.

Run No. 4.—Ullrich magnetic separator—

Feed, recalcined and new wet.
Distance of feed from rings, ½ inch.
Current strength, 10 amperes at 110 volts.
Concentrate analysis, 0·13 per cent Fe.

Run No. 5.—Huff electrostatic separator—

Feed, dry.
Distance of electrode from roll, 1½ inches.
Voltage on electrode, 27,000.
Concentrate analysis, 0·12 per cent Fe.
Tailing analysis, 0·12 per cent Fe.

Run No. 6.—Huff electrostatic separator—

Feed, dry.
Dist. electrode from roll, 1½ inches.
Voltage on electrode, 20,000.
Concentrate analysis, 0·13 per cent Fe.
Tailing analysis, 0·13 per cent Fe.

Run No. 7.—Gröndal magnetic separator—

Feed, wet.
Current strength, 6·5 amperes at 110 volts.
Concentrate analysis, 0·23 per cent Fe.

Conclusions.—The iron content in the bauxite concentrate does not exist as separate particles, nor does any of the particles contain greater proportions of it, but it is so intimately mixed through all the particles that a magnetic or electrostatic separation is impossible.

Test No. 25.

Two hundred pounds of serpentine rock, carrying asbestos and chromite, was received from the Geological Survey, Ottawa.

Concentration tests were conducted on the laboratory Wilfley table to obtain a separation of the asbestos and chromite from the rock material.

The rock was crushed to pass through a 20-mesh screen by successive crushing and rolling: 4·625 pounds of asbestos fibre was caught on the 20-mesh screen.

The undersize, through 20-mesh, was sized on the following screen set, and the weights of each size noted:—

Size,	— 20 + 30.	Weight,	78·00	lb.
“	— 30 + 40.	“	22·50	“
“	— 40 + 50.	“	23·00	“
“	— 50 + 60.	“	11·75	“
“	— 60 + 80.	“	8·25	“
“	— 80 +100.	“	8·75	“
“	—100 +150.	“	9·50	“
“	—150.	“	19·00	“

Wilfley concentration of size — 20 + 30—

First concentrates	1·375	lb.
“ middlings	12·250	“
“ tailings	54·000	“
Second concentration from reconcentration of middlings	1·375	“
“ middlings from reconcentration of middlings	2·750	“
“ tailings “ “ “	8·000	“
Slime fibre from first and second concentration	0·500	“

Wilfley concentration of size — 30 + 40—

First concentrates	1·250	lb.
“ middlings	5·375	“
“ tailings	13·250	“
Second concentrates from reconcentration of middlings	0·3125	“
“ middlings “ “ “	2·0000	“
“ tailings “ “ “	3·0000	“
Slime fibre from first and second concentration	0·3125	“

Wilfley concentration of size — 40 + 50—

First concentrates	0·875	lb.
“ middlings	3·000	“
“ tailings	16·250	“
Second concentrates from reconcentration of middlings	0·1875	“
“ middlings “ “ “	0·6875	“
“ tailings “ “ “	2·0625	“
Slime fibre from first and second concentration	0·5625	“

Wilfley concentration of size — 50 + 60—

Concentration obtained	—0·4375	lb.
Middlings “	—1·5000	“
Tailings “	—7·5000	“
Slime fibre “	—0·3125	“

Wilfley concentration of size — 60 + 80—

Concentrates obtained	—0·2500	lb.
Middlings “	—0·8750	“
Tailings “	—5·0000	“
Slime fibre “	—0·3750	“

Wilfley concentration of size — 80 + 100—

Concentrates obtained	—0·344	lb.
Middlings “	—0·8125	“
Tailings “	—5·0000	“
Slime fibre “	—0·6875	“

Wilfley concentration of size — 100 + 150—

Concentrates obtained	—0·3125 lb.
Middlings "	—0·6250 "
Tailings "	—4·5000 "
Slime fibre "	—0·8750 "

Wilfley concentration of size — 150—

Concentrates obtained	—0·5000 lb.
Middlings "	—1·1250 "
Tailings "	—7·0000 "
Slime fibre "	—1·5000 "

TEST NO. 26.

ZINC CONCENTRATES FROM NOTRE DAME MINE.

A small shipment of 200 pounds of zinc concentrate was received from Mr. David A. Poe. The concentrate is a table-and-jig product, analysis showing it to contain zinc, 26·07 per cent; iron, 26·22 per cent; copper, 0·33 per cent. Tests were run to obtain a zinc product high in zinc and low in iron content.

Run No. 1.—Magnetic separation followed by electrostatic separation of non-magnetic product.

Wet separation on the Ullrich magnetic separator was employed. A current strength of 5 amperes at 110 volts was used on the machine. The rings were set half an inch from the feed plates. The results of the operation are tabulated below:—

Products.	Weight.	Percentage by weight.	Analysis per cent.		Contents pounds.		Concentration. per cent.	
			Zn.	Fe.	Zn.	Fe.	Zn.	Fe.
	lb.—oz.							
Pyrrohite	43—0	26·7	7·22	48·90	3·105	21·027	7·40	49·82
Zinc	118—0	73·3	32·94	17·95	38·869	21·181	92·60	50·18
Totals and averages	161—0	100·0	26·07	26·22	41·974	42·208	100·00	100·00

The zinc product was divided into two portions; one was held to be given a magnetic roast, and separated magnetically, while the other was passed again through the separator, the current strength increased to 10 amperes at 110 volts, the rings remaining at half an inch from the feed plates. The following tabulated results were obtained:—

Product.	Weight.	Percentage by weight.	Analysis per cent.		Contents pounds.		Concentration per cent.	
			Zn.	Fe.	Zn.	Fe.	Zn.	Fe.
	lb.—oz.							
Magnetite	16—12	11·5	31·19	23·01	2·105	1·553	11·04	14·30
Non-magnetite	51—12	88·5	32·79	17·99	16·969	9·310	88·96	85·00
Totals and averages	58—8	100·0	32·61	18·57	19·074	10·863	100·00	100·00

The above results are combined in the following table:—

Product.	Weight.	Percentage by weight.	Analysis per cent.		Contents pounds.		Concentration per cent.	
			Zn.	Fe.	Zn.	Fe	Zn.	Fe.
	lb.—oz.							
1st Magnetic..	43—0	26·7	7·22	48·90	3·105	21·027	7·47	48·97
2nd "	13—9	8·4	31·19	23·01	4·231	3·122	10·17	7·27
Non "	104—7	64·9	32·79	17·99	34·243	18·787	82·36	43·76
Totals and averages....	161—0	100·0	25·82	26·48	41·579	42·936	100·00	100·00

The non-magnetic product was screened on an 8-mesh screen, and the oversize crushed to pass through 8-mesh. The material was sized, and the sized products treated separately on the Huff electrostatic separator. As considerable gangue material was noticeable, three products were made: a zinc product, an iron product, and a calcite product. The results of the separation are contained in the following table:—

HEAD.

Sized Product.	Weight.		Percentage of sized product.	Analysis.		Contents.		Voltage on Electrode for	
	lb.	oz.		Per Cent. Zn.	Per Cent. Fe.	lb. Zn.	lb. Fe.	Fe Prod.	Calcite Prod.
− 8 +10	12	12	13·0	30·40	20·43	3·876	2·605	27·000	24·000
−10 +20	21	12	22·1	29·35	18·34	6·364	3·989	27·000	24·000
−20 +40	31	8	32·1	22·73	17·75	7·160	5·591	27·000	26·000
−40 +80	24	0	24·4	31·90	17·03	7·656	4·087	23·000	26·000
−80	8	4	8·4	29·40	16·43	2·426	1·355	24·000	17·000
Totals and averages..	98	4	100·0	27·97	17·94	27·482	17·627	...	... .

IRON PRODUCT.

Sized Product.	Weight.		Percentage of sized product.	Analysis.		Contents.		Percentage.	
	lb.	oz.		Per Cent. Zn.	Per Cent. Fe.	lb. Zn.	lb. Fe.	Zinc. Loss.	Fe. Recovery
− 8 +10	3	4	3·31	21·79	28·37	0·806	0·922	2·935	5·225
−10 +20	6	8	6·62	18·25	29·63	1·186	1·926	4·320	10·910
−20 +40	4	12	4·83	11·93	34·52	0·559	1·610	2·033	9·30
−40 +80	2	9	2·608	20·85	30·29	0·534	0·776	1·945	4·40
−80	0	10	·632	30·05	27·39	0·188	0·171	·684	·970
Totals and averages..	17	11	18·004	18·50	30·71	3·273	5·435	11·917	30·805

ZINC PRODUCT.

Sized product.	Weight.		Percentage of sized product.	Analysis.		Contents.		Percentage.	
	lb.	oz.		Per Cent. Zn.	Per Cent. Fe.	lb. Zn.	lb. Fe.	Zinc Recovery.	Fe. in Zn. Prod.
− 8 +10	6	12	6·86	27·31	18·65	1·843	1·259	6·715	7·137
−10 +20	12	14	13·09	35·05	12·75	4·513	1·642	16·430	9·320
−20 +40	23	4	23·65	39·95	10·43	9·288	3·820	33·800	21·70
−40 +80	14	2	14·49	37·00	17·03	5·226	2·405	19·050	13·65
−80	5	0	5·08	34·75	17·95	1·838	0·898	6·685	5·10
Totals and averages..	62	0	63·17	36·63	16·17	22·708	10·024	82·68	58·90

CALCITE PRODUCT.

Sized product.	Weight.		Percentage of sized product.	Analysis.		Contents.		Percentage.	
	lb.	oz.		Per Cent. Zn.	Per Cent. Fe.	lb. Zn.	lb. Fe.	Zinc.	Fe.
− 8 +10	0	12	·7625	28·25	10·42	0·212	0·078	771	·4425
−10 +20	0	12	·7625	18·80	5·10	0·142	0·038	·517	·2155
−20 +40	3	4	3·305	18·35	3·96	0·596	0·129	2·170	·7325
−40 +80	7	0	7·120	25·70	8·78	1·799	0·615	6·540	3·490
−80	3	2	3·170	21·85	11·96	0·683	0·373	2·482	2·115
Totals and averages..	14	14	15·12	23·07	8·29	3·432	1·233	12·48	6·9955

A summary of the above results is contained in the table given below:—

Products.	Weight.		Percentage by weight.	Analysis.		Contents—lb.		Concentration.	
	lb.	oz.		Per Cent. Zn.	Per Cent. Fe.	Zn.	Fe.	Per Cent Zn.	Per Cent. Fe.
1st Magnetic	43	0	26·7	7·22	48·90	3·105	21·027	7·80	49·38
2nd "	13	9	8·4	31·19	23·01	4·231	3·122	10·62	7·33
Iron........	19	9	12·1	18·50	30·71	3·613	5·998	9·07	14·09
Calcite.... ..	16	6	10·2	23·07	8·29	3·783	1·300	9·50	3·19
Zinc........	68	8	42·6	36·63	16·17	25·096	11·078	63·01	26·01
Totals and averages..	161	0	100·0	24·73	26·45	39·828	42·585	100·00	100·00

Zinc Product—

42·6 % of crude concentrates.
Analysis: zinc, 36·63 %; iron, 16·17 %.
Recovery: 63·01 % of zinc values.
Iron removed from zinc product, 74% of iron values in crude concentrate.

Combined zinc and calcite product—

52·8 % of crude concentrate.

Calculated analysis, zinc, 34·02 %; iron, 14·65 %.

Recovery: 72·51 % of zinc values.
Iron removed from zinc and calcite products: 70·8 % of iron values in crude concentrate.

Run No. 2.—Magnetic separation followed by roasting and magnetic separation of roasted product.

As given above under run No. 1, the concentrate was first passed through the Ullrich magnetic separator. The current strength on the machine was 5 amperes at 110 volts and the rings were set half an inch from the feed plates. The following table shows the separation obtained:—

Product.	Weight.		Percentage by weight.	Analysis per cent.		Contents pounds.		Concentration per cent.	
	lb.	oz.		Zn.	Fe.	Zn.	Fe.	Zn.	Fe.
Magnetic..	43	0	26·7	7·22	48·90	3·105	21·027	7·40	49·82
Non-magnetic......	118	0	73·3	32·94	17·95	38·869	21·181	92·60	50·18
Totals and averages..	161	0	100·0	26·07	26·22	41·974	42·208	100·00	100·00

One portion of the zinc product was given a magnetic roast, and passed through the separator. The current strength was increased to 10 amperes at 110 volts, the rings remaining at half inch from the feed plates. The results obtained are given in the following table:—

Product.	Weight.		Percentage by weight.	Analysis per cent.		Contents pounds.		Concentration per cent.	
	lb.	oz.		Zn.	Fe.	Zn.	Fe.	Zn.	Fe.
Magnetic...	9	0	28·4	17·95	38·38	1·616	3·454	14·38	59·45
Non-magnetic......... ..	22	12	71·6	42·31	16·36	9·626	2·356	85·62	40·55
Totals and averages..	31	12	100·0	35·41	18·30	11·242	5·810	100·00	100·00

The above results are combined in the following table:—

Product.	Weight		Percentage by weight.	Analysis per cent.		Contents pounds.		Concentration per cent.	
	lb.	oz.		Zn.	Fe.	Zn.	Fe.	Zn.	Fe.
1st Magnetic............	43	0	26·7	7·22	48·90	3·105	21·027	7·40	51·14
2nd Magnetic..	31	2	19·3	17·95	38·38	5·587	11·946	13·31	29·05
Non-magnetic.	78	10	48·8	42·31	10·36	33·266	8·146	79·29	19·81
Roasting loss, etc........	8	4	5·2	....	....	.... ..	. .....	....	....
Totals and averages..	161	0	100·0	26·01	25·56	41·958	41·119	100·00	100·00

The final zinc product obtained represents 48·8 % by weight of the crude concentrate. Analysis: zinc, 42·31% ; iron, 10·36%.

Recovery: 79·29 % of the zinc values.

Iron removed from zinc product: 80·19 % of iron values in crude concentrate.

TEST No. 27.

MAGNETITE-CHALCOPYRITE ORE.

A small 12-pound sample of this ore was received from R. R. Hedley, of Vancouver, B.C. The ore is magnetite with chalcopyrite, finely disseminated, which necessitates fine grinding to free the particles.

The sample was crushed to pass through a 100-mesh screen, a sample taken for analysis, and the remaining portion divided into small lots for testing purposes.

One portion of the ore was run through the Gröndal laboratory type dry magnetic separator, but it was found that this machine did not work satisfactorily on the ore in such a finely divided state. The laboratory Gröndal wet magnetic separator was not adapted to the separation of the ore, as there was considerable loss of the copper values in slime being carried over with the magnetic product. The construction of the Ullrich wet magnetic separation was best adapted to the ore, as the magnetic product was pulled out by the rings, while the shaking feed had a tendency to submerge the slime particles which were carried off with the non-magnetic product. Although only a current strength of 2·5 amperes at 65 volts was carried on the machine, the intense field drew considerable of chalcopyrite particles along with the magnetic product.

A preliminary run of a portion of the ore through the Ullrich wet magnetic separator gave products with the following analysis:—

Magnetic product:	Fe—67·93 %,	Cu—0·462 %,	S—1·438 %
Copper product:	Fe—24·78 %,	Cu—9·420 %,	S—.......

The results obtained from the final run on a portion of the ore through the Ullrich magnetic separator are tabulated below:—

The analysis of the slime loss was figured by subtracting the sum of the combined metallic contents in the magnetic and copper products from that in the original heads.

Tons of magnetic products made per ton of crude: 0·875.

The units of crude required per unit of magnetic product: $\frac{100}{87\cdot5} = 1\cdot14$

Percentage of iron in the crude saved in the magnetic product: 93·8.
Tons of magnetic product made per ton of crude: 0·875.

The units of crude required per unit of copper product: $\frac{100}{10\cdot4} = 9\cdot615$

Percentage of copper in the crude saved in the copper product: 48·7

STRENGTH of Current: 2·5 Amperes, 65 Volts.

Product.	Weight.		Percentage by weight.	Analysis per cent.			Contents pounds.			Concentration per cent.		
	lb.	oz.		Fe.	Cu.	S.	Fe.	Cu.	S.	Fe.	Cu.	S.
Magnetite..........	2	10	87·5	66·09	0·602	1·92	1·735	0·0158	0·0504	93·8	31·5	45·0
Copper..............	0	5	10·4	27·72	7·800	.....	0·087	0·0244	....	4·7	48·7	.....
Slime loss.....	0	1	2·1	28·80	15·040	......	0·018	0·0099	......	1·5	19·8	.. .
Heads...........	3	0	100·0	61·65	1·670	3·74	1·850	0·0501	0·1122	100·0	100·0	100·0

TEST No. 28.

HIGH PHOSPHORUS TAILINGS FROM MOOSE MOUNTAIN IRON MINE, SELLWOOD, ONTARIO.

A small sample of tailings from the concentration plant of the Moose Mountain, Limited, was received at the plant of the ore dressing laboratory.

Tests were conducted on this sample to obtain a product high in phosphorus content.

A portion of the sample was run through the Ullrich wet magnetic separator, and the non-magnetic product from the separator run over the small laboratory Wilfley table.

Ullrich separation—

Current strength: 10 amperes, 110 volts.
Distance of rings from feed: ½-inch.
Analysis of head sample: 0·197 per cent P.
Analysis of magnetic product: 0·417 per cent P.
Weight of magnetic product: 9·1 per cent of crude.
Magnetic product contains 19·2 per cent of Phos. in heads.
Analysis of non-magnetic product: 0·175 per cent P.
Weight of non-magnetic product: 90·9 per cent of crude.
Non-magnetic product contains 80·8 per cent of Phos. in heads.

Wilfley concentration of Ullrich separator tailings—

Wilfley concentrates = 17·2 % by weight.
Analysis = 0·330 % P.
Concentrate contains = 33·2 % of Phos. in separator tailing.
Wilfley middlings = 35·5 % by weight.
Analysis = 0·112 % P.
Middling contains = 23·2 % of Phos. in separator tailing.
Wilfley tailings = 34·2 % by weight.
Analysis = 0·075 % P.
Tailings contain = 14·4 % of Phos. in separator tailing.
Wilfley slimes = 13·1 % by weight.
Analysis = 0·374 % P.
Slimes contain 28·6 % of Phos. in separator tailing.

SUMMARY.

Product.	Analysis per cent phosphorus.	Per cent phosphorus in products.
Separator concentrates	0·417	19·2
Wilfley concentrates	0·330	26·8
" middlings	0·112	18·7
" tailings	0·075	11·6
" slimes	0·374	23·1
Head sample	0·197	99·4

Test No. 29.

A 200-pound shipment of ilmenite ore was received at the testing laboratory from Mr. Girard. Several concentration tests were conducted on this ore on application of Mr. G. C. Bateman of the Canadian Mining and Exploration Company.

Run No. 1.—One bag of the ore was taken and crushed to pass a 10-mesh screen (·075-inch aperture). A sample was obtained for analysis by passing the material through Jones riffled sampler.

This sample gave an analysis of—

Fe	33·65	per cent.
TiO_2	33·60	"
SiO_2	6·72	"
$CaCO_3$	5·48	"
$MgCO_3$	7·30	"

The material through 10-mesh was then sized on 20-mesh (·034-inch aperture) and on 40-mesh (·015-inch aperture) screens resulting in the following sizes:—

— ·075″ + ·034″—

Weight, 29·00 lb.

Analysis, Fe	34·45	per cent.
TiO_2	33·31	"
Insol	6·64	"

— ·034″ + ·015″—

Weight, 14·25 lb.

Analysis, Fe	34·10	per cent.
TiO_2	33·89	"
Insol	6·75	"

— ·015″—

Weight, 17·25 lb.

Analysis, Fe	32·05	per cent.
TiO_2	32·81	"
Insol	6·78	"

Weights of sized products after sampling—

— ·075″ + ·034″ — 28·250 lb.
— ·034″ + ·015″ — 14·125 lb.
— ·015″ — 17·000 lb.

To the sized material was added 5 per cent by weight of powdered charcoal, and each size given a reducing roast to make the iron content more magnetic.

Dry Magnetic Separation on the Ullrich Separator

The sizes were passed separately.

The current strength on the magnets was 4·3 amperes at 110 volts.

The rings were set at half an inch from the feed plates.

No appreciable difference was noticed in the magnetic and non-magnetic products. The gangue material was evidently drawn up with the magnetic material while the non-magnetic products showed it to contain an equal amount of ilmenite particles as the magnetic products.

Wet Magnetic Separation on the Ullrich Separator.

Size, — ·075 inch + ·034 inch. Weight, 25·50 lb.

Current strength on the magnets, 4·3 amperes, 110 volts.

Rings set at ½ inch from the feed plates.

Magnetic product. Weight, 25·00 lb.

Analysis, Fe. . . . . 31·65 per cent.
TiO_2. . . . . 37·14 "
Insol. . . . . 7·41 "

Non-magnetic product. Weight, 0·50 lb.

No analysis was determined, as this product contained a considerable amount of charcoal.

Size, — ·034 + ·015. Weight, 12·00 lb.

Current strength on magnets, 4·3 amperes, 110 volts.

Rings set at ½ inch from the feed plates.

Magnetic product. Weight, 11·75 lb.

Analysis, Fe. . . . . 33·75 per cent.
TiO_2. . . . . 33·17 "
Insol. . . . . 6·63 "

Non-magnetic product. Weight, 0·25 lb.

No analysis was determined as this product contained a considerable amount of charcoal.

Size, — ·015. Weight, 15·00 lb.

Current strength on magnets, 4·3 amperes, 110 volts.

Rings set at ½ inch from the feed plates.

Magnetic product. Weight, 12·50 lb.

Analysis, Fe. . . . . 33·00 per cent.
TiO_2. . . . . 30·60 "
Insol. . . . . 9·84 "

Non-magnetic product. Weight, 1·25 lb.

No analysis was determined as this product contained a considerable amount of charcoal.

The above operation shows that no marked concentration has been made.

This may be due to the difficulty experienced in obtaining an even roast.

Electrostatic Separation of the Magnetic Products from the Ullrich Magnetic Separator.

Size, — ·075″ + ·034″—

Voltage on electrode, 25,000.

Distance of electrode from roll, 2 inches.

Passes, 2.

Analysis of concentrates, Fe. . . . . 33·18 per cent.
TiO_2. . . . . 34·00 "
Insol. . . . . 6·69 "

Size, — ·034″ + ·015″—

Voltage on electrode, 20,000.

Distance of electrode from roll, 2 inches.

Passes, 1.

Analysis of concentrates,	Fe.	33·53	per cent.
	TiO_2.	36·71	"
	Insol.	6·80	"

Size, — ·015—

Voltage on electrode, 18,000.

Distance of electrode from roll, 2 inches.

Passes, 1.

Analysis of concentrates,	Fe.	31·69	per cent.
	TiO_2.	35·17	"
	Insol.	8·38	"

This operation shows that with the finer sizes the TiO_2 content is raised 5 per cent, the insoluble content remaining about the same. This, however, is at the expense of losing a large percentage of the TiO_2 content in the tailings.

The concentrate obtained from the electrostatic separator of the size — ·015 was run over the laboratory dry magnetic separator. The analysis of the concentrate obtained was: Fe, 35·17%; TiO_2, 37·34%; and insoluble, 4·46%. Analysis of the tailing showed it to contain 9·72% insoluble. This concentration was obtained also at the expense of losing a large percentage of the TiO_2 content in the tailings.

Run No. 2.—One bag of the ore was taken and crushed in the jaw crusher and rolls, and re-ground in pebble jars. A sample was taken for analysis which showed it to contain:—

Iron.	33·03	per cent.
TiO_2.	29·82	"
Insol.	13·30	"

A screen analysis was also made to determine the state of fineness of the ore after re-grinding:—

Mesh.	Aperture.	Weight.	Percentage.	Accummulated.
+ 80	+ ·0062″	3·17 oz.	17·36	17·36
− 80 + 100	+ ·0050″	0·78 "	4·27	21·63
− 100 + 120	+ ·0042″	1·17 "	6·41	28·04
− 120 + 150	+ ·0032″	1·04 "	5·70	33·74
− 150 + 200	+ ·0025″	4·11 "	22·51	56·25
− 200	− ·0025″	7·99 "	43·76	43·76

Twenty-six pounds of the crushed ore were taken, to which were added 2 pounds of powdered charcoal, and the whole mixed thoroughly, and given a reducing roast.

A small sample of the roasted ore was run through the laboratory Gröndal wet magnetic separator. Only a small portion of the more finely divided material came over as concentrates. This was due to the weak field of the magnets, which is only adaptable to highly magnetic material.

The remainder of the roasted ore was run through the Ullrich wet magnetic separator.

Current strength on the magnets, 4·3 amperes, 110 volts.

Distance of rings from feed plates, ½ inch.

Concentrates obtained gave an analysis of:—Fe, 35·25 per cent; TiO_2, 33·53 per cent; insoluble, 9·65 per cent.

By this operation the content of the concentrate shows an increase over the content of the original ore of: Iron, 2·22 per cent; TiO_2, 3·71 per cent; insoluble, 3·65 per cent.

Run No. 3.—One bag of the ore was taken and crushed in the laboratory jaw crusher and rolls to pass through a 5-mesh (0·159″ aperture) screen. The material through 5-mesh was sized on 10, 20, 40, and 80-mesh. The following weights and analysis of the various sizes were obtained:—

Sizes.	Weight.	Analysis.		
		Per cent Fe.	Per cent TiO_2	Per cent Insoluble.
	Pounds.			
− 0·1590 + 0·0750	33·75	36·40	33·75	8·28
− 0·0750 + 0·0340	17·25	36·38	33·49	8·29
− 0·0340 + 0·0150	10·50	36·12	31·99	9·82
− 0·0150 + 0·0068	5·50	34·55	30·96	10·85
− 0·0068	8·50	33·05	28·89	12·88
Totals and averages.. .	75·50	35·85	32·70	9·20

Size, — 5 + 10 mesh (— 0·1590 + 0·0750)—

Weight, 33·75 pounds; weight of sample, 1·25 pounds. Concentrated on laboratory Richard's pulsator jig.

Jig Concentrates—

Weight, 28 lb.
Analysis, Fe.. .. .. 36·10 per cent.
TiO_2.. .. .. 33·82 “
Insol.. .. .. 8·52 “

Jig Tailings—

Weight, 4·5 lb.
Analysis, Fe.. .. .. 34·60 per cent.
TiO_2.. .. .. 31·56 “
Insol.. .. .. 12·11 “

Size, — 10 + 20 mesh (— 0·0750 + 0·0340)—

Weight, 17·25 pounds; weight of sample, 0·25 pounds.
Concentrated on laboratory Richard's pulsator jig.

Jig Concentrate—

Weight, 14·5 lb.
Analysis, Fe.. .. .. 36·91 per cent.
TiO_2.. .. .. 33·60 “
Insol.. .. .. 7·90 “

Jig Tailings—

Weight, 2·5 lb.
Analysis, Fe.. .. .. 33·43 per cent.
TiO_2.. .. .. 30·68 “
Insol.. .. .. 13·05 “

Size, — 20 + 40 mesh (— 0·0340 + 0·0150)—

Weight, 10·50 pounds; weight of sample, 3·50 pounds.
Concentrated on laboratory Richard's pulsator jig.

Jig Concentrate—

Weight, 5·75 lb.
Analysis, Fe.. .. .. 37·15 per cent.
TiO_2.. .. .. 33·53 "
Insol.. .. .. 8·06 "

Jig Tailings—

Weight, 1·25 lb.
Analysis, Fe.. .. .. 32·05 per cent.
TiO_2.. .. .. 24·67 "
Insol.. .. .. 17·13 "

Jig products mixed and reconcentrated on laboratory Wilfley table.

Wilfley Concentrate—

Weight, 2·50 lb.
Analysis, Fe.. .. .. 36·15 per cent.
TiO_2.. .. .. 33·39 "
Insol.. .. .. 9·02 "

Wilfley Tailings—

Weight, 0·50 lb.
Analysis, Fe.. .. .. 32·85 per cent.
TiO_2.. .. .. 27·02 "
Insol.. .. .. 14·87 "

Size, — 40+80 mesh (—0·0150+0·0068)—

Weight, 5·50 lb.; weight of sample, 0·50 lb.
Concentrated on laboratory Wilfley table.

Wilfley Concentrates—

Weight, 3·375 lb.
Analysis, Fe.. .. .. 35·59 per cent.
TiO_2.. .. .. 33·97 "
Insol.. .. .. 9·11 "

Wilfley Tailings—

Weight, 1·625 lb.
Analysis, Fe.. .. .. 31·85 per cent.
TiO_2.. .. .. 28·35 "
Insol.. .. .. 14·97 "

Size, — 80 mesh (— 0·0068)—

Weight, 8·50 lb; weight of sample, 0·50 lb.
Only a portion of this size was run over the laboratory Wilfley table.

Wilfley Concentrates—

Weight, 1·125 lb.
Analysis, Fe.. .. .. 36·00 per cent.
TiO_2.. .. .. 33·88 "
Insol.. .. .. 8·79 "

GRAPHIC METHOD OF ILLUSTRATING EXTRACTION

ZINC MIDDLINGS

RUN NO. 1. TEST NO. 30

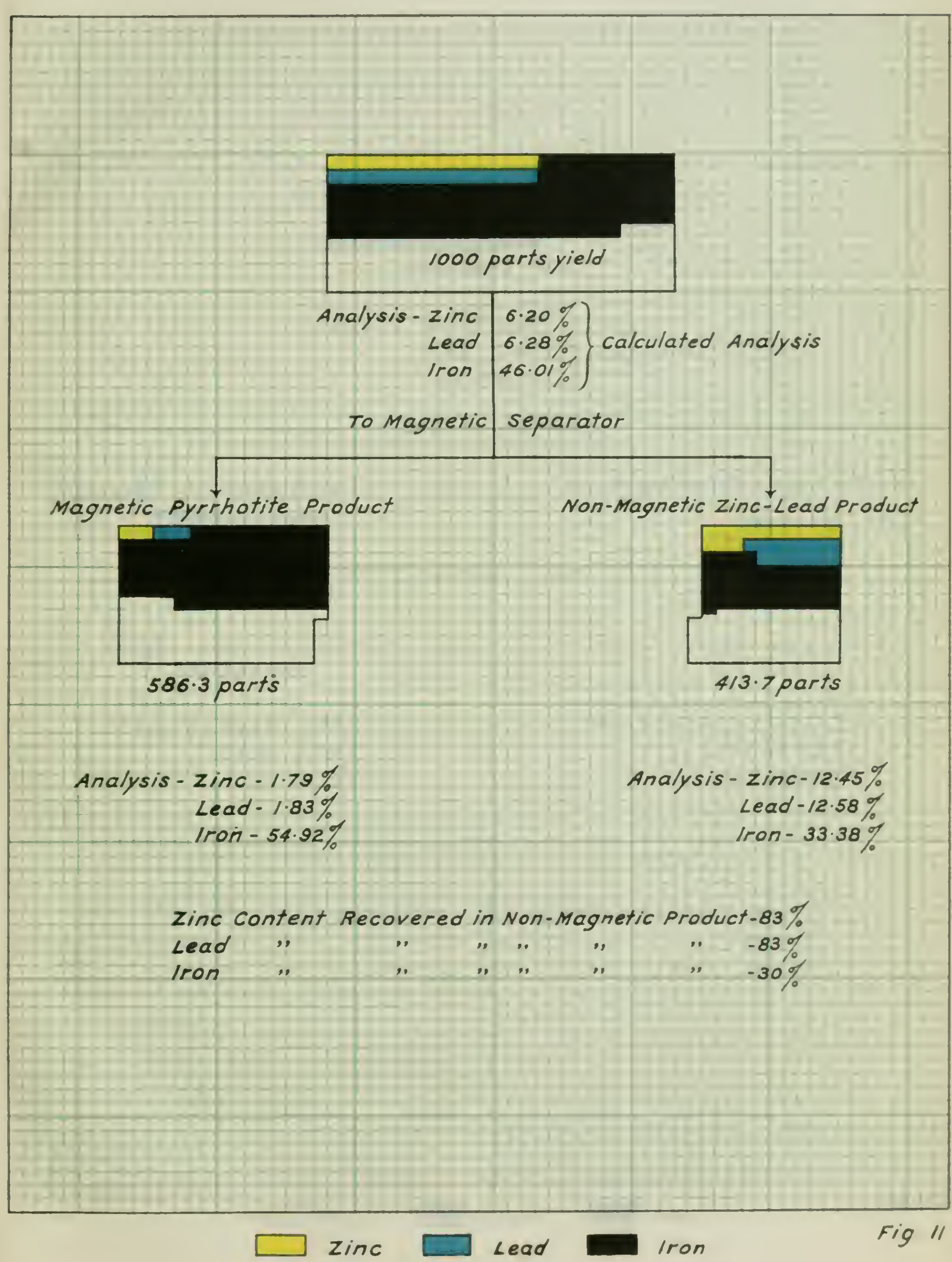


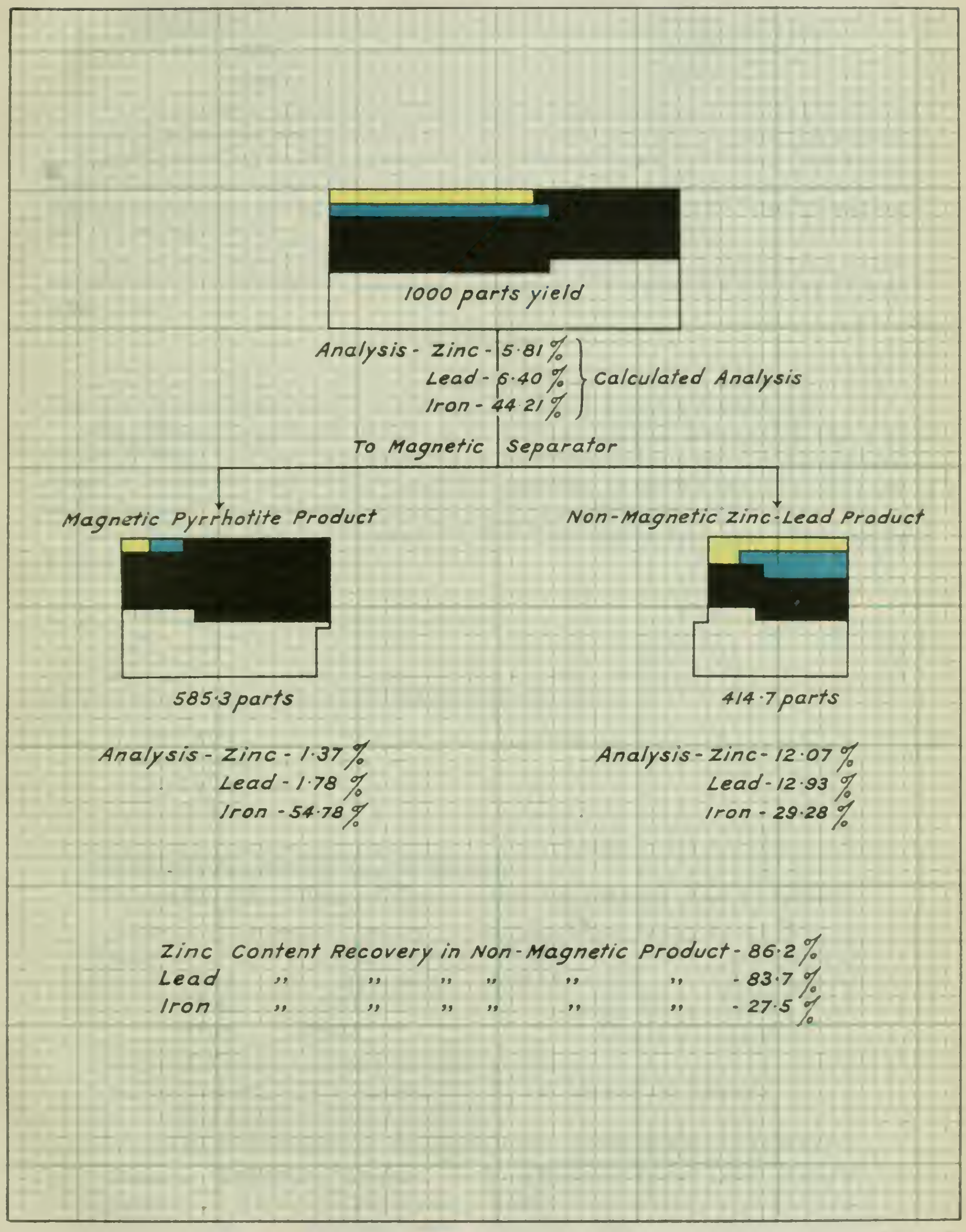
Fig 11

2

GRAPHIC METHOD OF ILLUSTRATING EXTRACTION

ZINC MIDDLINGS

RUN NO. 2, TEST NO 30



Zinc Content Recovery in Non-Magnetic Product - 86·2 %
Lead " " " " " " - 83·7 %
Iron " " " " " " - 27·5 %

🟨 Zinc 🟦 Lead ⬛ Iron

Fig 12

[illegible]

[illegible]

Wilfley Tailings—

Weight, 0·875 lb.

Analysis, Fe	31·55	per cent.
TiO_2	24·55	"
Insol	17·39	"

From the above treatment, the TiO_2 content of the concentrate obtained, shows an increase of 1 per cent over the content of the original ore, and the insoluble content has been decreased by a similar amount. On the coarser sizes + 20 mesh there is very little difference, but on the finer sizes — 20 mesh the TiO_2 content of the concentrate shows an increase of from 2 per cent to 4 per cent over the content of the original ore, and the insoluble content has been decreased by a similar amount.

The jig and table products were mixed together, re-sized, and the sizes treated separately on the electrostatic separator. No noticeable separation was seen to have taken place.

Test No. 30.

A shipment of 240 pounds of zinc middlings from the concentrating plant of the Blue Bell Mine, Riondel, B.C., was received at the ore testing laboratories.

The shipment was made by Mr. S. S. Fowler, general manager of the New Canadian Metal Co., Ltd., who asked for a test to be made on the Ullrich magnetic separator, in the wet way, with the object of removing as much clean pyrrhotite, and leaving as much lead and zinc as possible in the non-magnetic product.

A sample was obtained by means of the Jones riffled samplers. This sample showed an analysis of:—

Zinc	7·68	per cent.
Lead	6·47	"
Iron	44·82	"

Run No. 1.—The circular rings of the separator were adjusted in steps with the following distances from the shaking feed plates:—

Outer ring	¾″
Second ring	⅝″
Third ring	½″
Fourth ring	⅜″

A current strength of 6·6 amperes, 90 volts was used on the magnets.

The duration of the run was 6·5 minutes.

The weights and analysis of the concentration products were as follows:—

Magnetic (Pyrrhotite) Product.			— Non-Magnetic (Zinc, Lead) Product.		
Weight	130·375 lb.		Weight	92·0 lb.	
Analysis—Zinc	1·79	per cent.	Analysis—Zinc	12·45	per cent.
Lead	1·83	"	Lead	12·58	"
Iron	54·92	"	Iron	33·38	"

Run No. 2.—Rings were left the same as run No. 1.

A current strength of 9·7 amperes, 97 volts was used on the magnets.

The duration of the run was 17 minutes.

The weights and analysis of the concentration products were as follows:—

Magnetic (Pyrrhotite) Product.			— Non-Magnetic (Zinc, Lead) Product.		
Weight	129·50 lb.		Weight	91·75 lb.	
Analysis—Zinc	1·37	per cent.	Analysis—Zinc	12·07	per cent.
Lead	1·78	"	Lead	12·93	"
Iron	54·78	"	Iron	29·28	"

TEST No. 31.

A shipment of 1,000 pounds of pyrite ore was received at the ore testing laboratories from the Northern Pyrites Company's mine at North Pines, Ontario.

The ore represented a considerable tonnage of the second run of mine, and consisted of pyrite and pyrrhotite with magnetite in a siliceous gangue.

PRELIMINARY TESTS.

The ore was crushed in the jaw crusher set at 1 inch opening, screened on a 2-mesh screen 0·437-inch aperture. The oversize was crushed in the laboratory jaw crusher set at ¼-inch opening and screened on the 2-mesh screen. The following sizes were obtained by screening:—

Size.	Aperture.	Weight.	Analysis.
Mesh.	Inches.	Pounds.	% Sulphur.
− 2+ 3	−0·437	300·186	33·55
− 3+ 4	−0·279	122·750	33·68
− 4+ 6	−0·203	96·125	31·17
− 6+ 8	−0·132	141·250	30·43
− 8+12	−0·097	146·938	28·78
−12+20	−0·060	35·186	28·82
−20+30	−0·034	25·625	28·95
−30+50	−0·0198	20·875	30·30
−50	−0·0110	92·813	30·45

Dry Magnetic Separation of Screen Sizes.

Size, —2+3. Weight, 285 lb.

Current strength on belt magnets, 4 amperes, 105 volts.
" " drum " 20 " 105 "
Belt travel, 311 feet per minute.
Tailing vane raised 5 inches.
Concentrates obtained, 67·75 lb. Analysis, 41·98 % S.
Tailings " 217·25 lb. " 29·61 % S.

Size, —3+4. Weight, 117·75 lb.

Current strength on belt magnets, 4 amperes, 105 volts.
" " drum " 20 " 105 "
Belt travel, 311 feet per minute.
Tailing vane raised 5 inches.
Concentrate obtained, 31·00 lb. Analysis, 41·44 % S.
Tailings " 86·75 lb. " 29·91 % S.

Size, —4+6. Weight, 90·5 lb.

Current strength on belt magnets, 4·7 amperes, 105 volts.
" " drum " 30 " 105 "
Belt travel, 311 feet per minute.
Tailing vane raised 3 inches.
Concentrate obtained, 31·25 lb. Analysis, 40·03 % S.
Tailings " 59·25 lb.

Size, — 6 + 8. Weight, 136 lb.

Current strength on belt magnets, 4 amperes, 105 volts.
“ “ drum “ 20 “ 105 “
Belt travel, 311 feet per minute.
Tailing vane raised 4 inches.
Concentrate obtained, 60·5 lb. Analysis, 38·78 % S.
Tailings “ 75·5 lb. “ 23·28 % S.

Size, — 8 + 12. Weight, 141·5 lb.

Current strength on belt magnets, 4 amperes, 100 volts.
“ “ drum “ 20 “ 100 “
Belt travel, 311 feet per minute.
Tailing vane raised 4 inches.
Concentrates obtained, 52·25 lb. Analysis, 40·25 % S.
Tailings “ 89·25 lb. “ 22·41 % S.

Size, — 12 + 20. Weight, 30·25 lb.

Current strength on belt magnets, 4 amperes, 98 volts.
“ “ drum “ 17·5 “ 98 “
Belt travel, 311 feet per minute.
Tailing vane raised 3½ inches.
Concentrates obtained, 13·5 lb. Analysis, 38·75 % S.
Tailings “ 16·75 lb. “ 20·54 % S.

Size, — 20 + 30. Weight, 21·5 lb.

Current strength on belt magnets, 4 amperes, 96 volts.
“ “ drum “ 15 “ 96 “
Belt travel, 311 feet per minute.
Tailing vane raised 3 inches.
Concentrates obtained, 11·0 lb. Analysis, 37·09 % S.
Tailings “ 10·5 lb. “ 19·90 % S.

Size, — 30 + 50. Weight, 16·375 lb.

Current strength on belt magnets, 4 amperes, 95 volts.
“ “ drum “ 12·5 “ 95 “
Belt travel, 311 feet per minute.
Tailing vane raised 2½ inches.
Concentrates obtained, 9·25 lb. Analysis, 38·70 % S.
Tailings “ 7·125 lb. “ 20·27 % S.

Size, — 50. Weight, 88·75 lb.

Separator did not work satisfactorily on the fines.

From the results obtained, and data collected on the above preliminary tests, it was found that a satisfactory separation could be made on the coarser sizes by the use of the dry magnetic separator, and that a separation could be made on the fines by magnetic separation, followed by table concentration, or vice versa.

Final Tests.

In order to simplify the process, the sizes used in the preliminary tests were grouped, and the tailings from the coarser sizes were re-crushed and added to the next size.

Size — 2 + 6 (— 0·437 + 0·132). Weight, 468 lb.—
Current strength on rectifying magnets, 4 amperes, 105 volts.
" " " drum " 20 " 105 "
Belt travel, 311 feet per minute.
Tailing vane raised 5 inches,
Concentrates obtained, 127 lb. Analysis, 41·51 % S.
Tailings " 341 lb. " 29·29 % S.
Weights of samples taken: Concentrates, 7 lb. 1 oz.
Tailings 5 lb. 8 oz.

The tailings, less the weight of the sample, were crushed in rolls to pass the 6-mesh screen, and sized on the 20-mesh screen. The oversize was added to the sizes —6 + 8, — 8 + 12, and — 12 + 20 from the preliminary test.

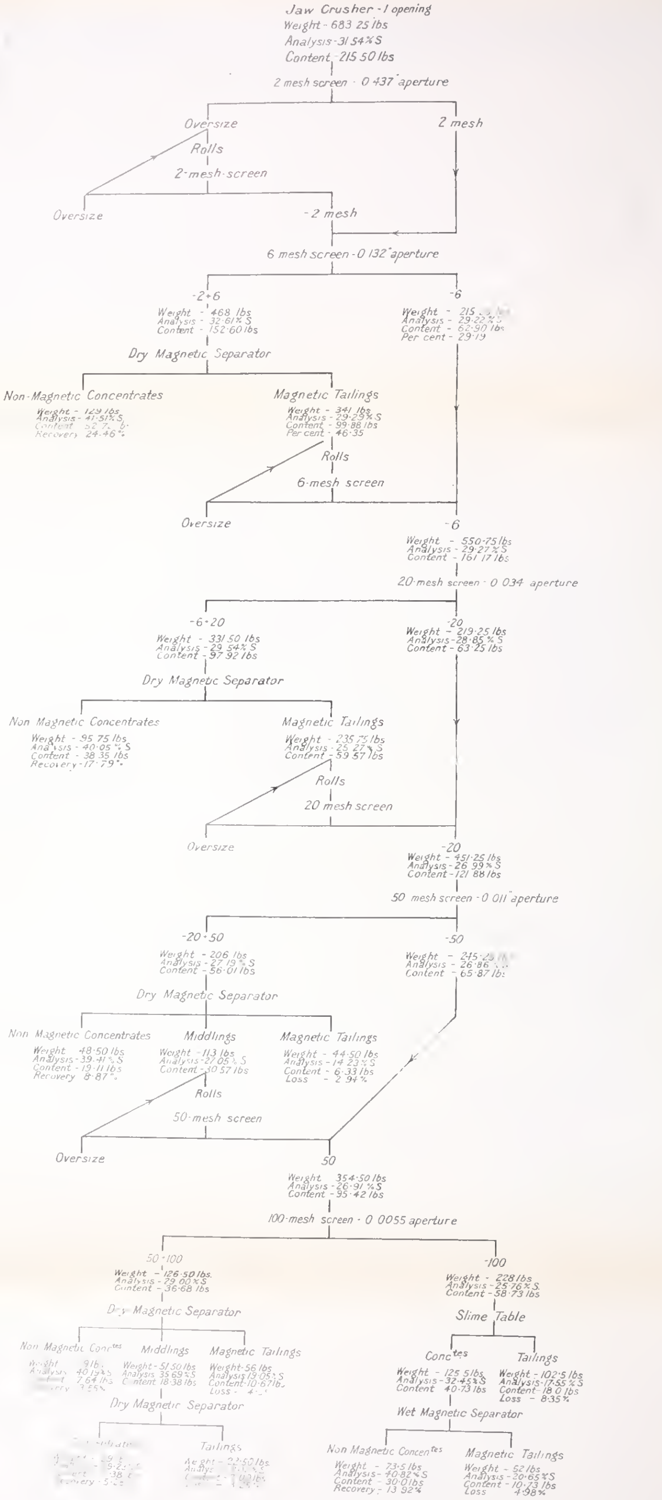
Size, — 6 + 20 (— 0·132″ + 0·234″). Weight, 331·5 lb.—
Current strength on rectifying magnets, 4 amperes, 103 volts.
" " " drum " 20 " 103 "
Belt travel, 311 feet per minute.
Tailing vane raised 4 inches.
Concentrates obtained. 95·75 lb. Analysis, 40·05 % S.
Tailings " 235·75 lb. " 25·27 % S.
Weight of samples taken: Concentrates, 3 lb. 3 oz.
Tailings 3 lb. 12 oz.

The tailings, less the weight of the sample, were crushed in rolls to pass the 20-mesh screen, and added to the re-crushed tailings from — 2 + 6 size through 20-mesh. These were sized on the 50-mesh screen, and the oversize added to the sizes, — 20 + 30 and — 30 + 50 from the preliminary test.

Size, —20 + 50 (0·034 + 0·011). Weight, 206 lb.—
Current strength on rectifying magnets, 4 amperes, 103 volts.
" " " drum " 20 " 103 "
Belt travel, 311 feet per minute.
Tailing vane raised 3½ inches.
Concentrate vane in No. 7 notch.
Concentrates obtained, 48·50 lb. Analysis, 39·41 % S.
Middlings " 113·00 lb. " 27·05 % S.
Tailings " 44·50 lb. " 14·23 % S.
Weights of samples taken: Concentrates, 3 lb. 1 oz.
Middlings 3 lb. 12 oz.
Tailings 2 lb. 12 oz.

The middlings, less the weight of the sample, were crushed in rolls to pass the 50-mesh screen, and added to the re-crushed tailings from the former sizes through 50-mesh, and to the size — 50 from the preliminary test. The products were mixed thoroughly, and screened on the 100-mesh screen.

Size, — 50 + 100 (— 0·011 + 0·055). Weight, 125·50 lb.
Current strength on rectifying magnets, 4 amperes, 108 volts.
" " " drum " 30 " 108 "
Belt travel, 311 feet per minute.
Tailing vane raised 3½ inches.
Concentrate vane in No. 5 notch.
Concentrates obtained, 19 lb. Analysis, 40·19 % S.



Concentrates - Weight 392·75 pounds or 57·48%
Content - 159·2 pounds of Sulphur
Calculated Analysis 40·56 % S
Recovery of Sulphur Content 73·78%

Tailings - Weight - 277·50 pounds or 40·62%
Content - 52·73 pounds of Sulphur
Calculated Analysis - 19·00 % S
Loss of Sulphur Content - 24·47 %

Samples taken weighed 13 pounds or 1·9%, Content 3·6 pounds, Analysis S - 26·84%; %age of S Content 1·75

Fig. 11. Flow sheet, showing concentration of pyrites on [illegible] Run No. 1, test No. 31. Northern Pyrites Co., North Pines, Ont.

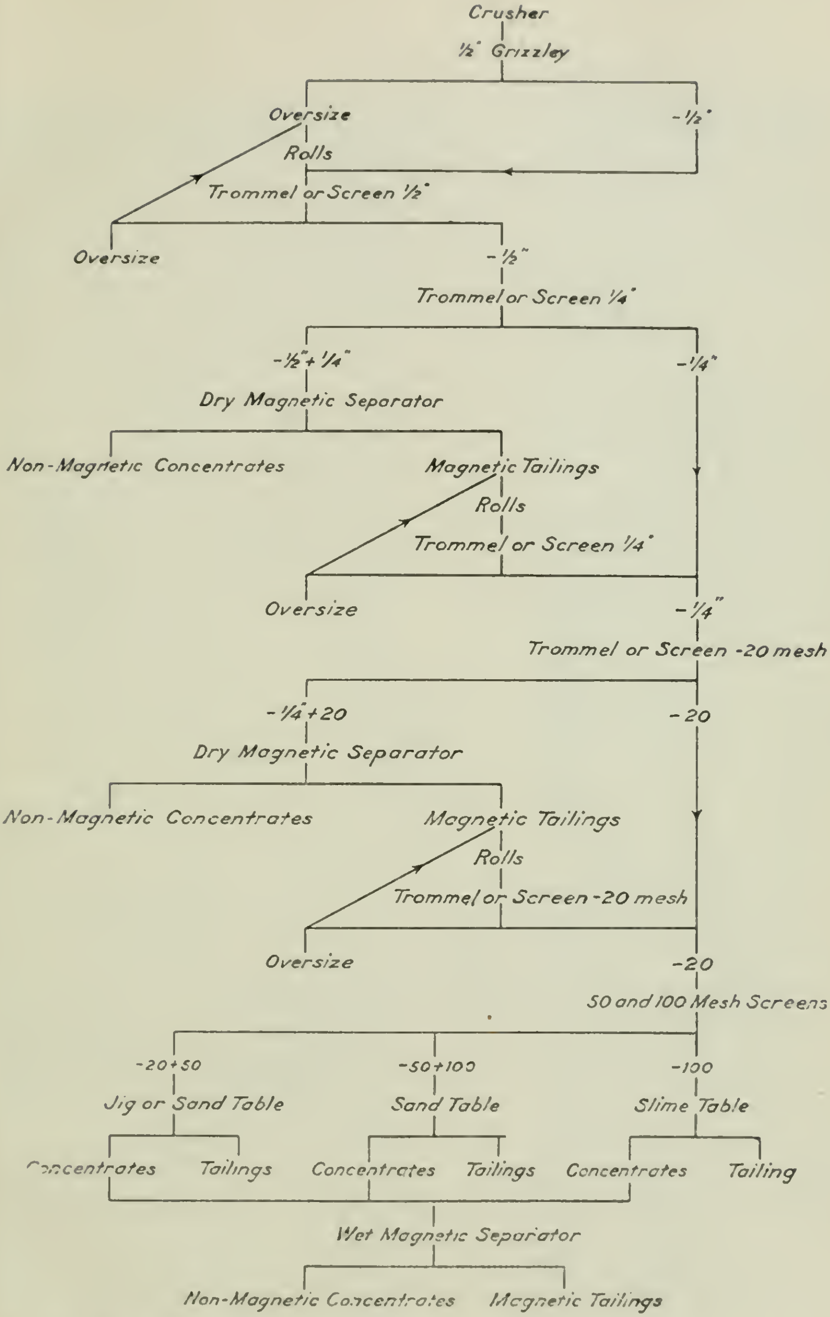


FIG. 14.—Flow sheet for concentration of pyrite ore. 2nd run of mine, Northern Pyrites Co., North Pines, Ont.

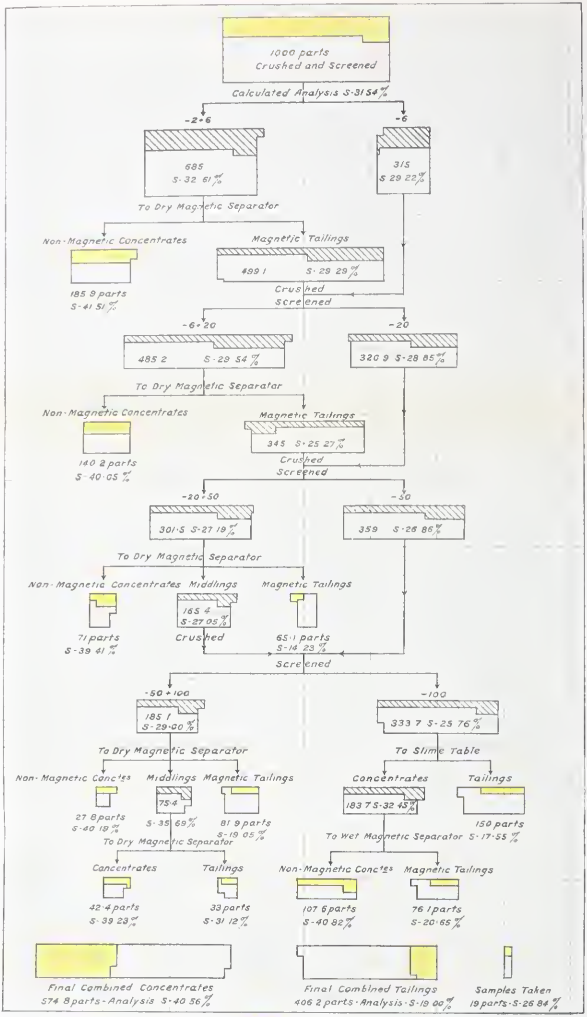

1000 parts
Crushed and Screened
Calculated Analysis S-31 54%
-2+6
-6
685
S-32 61%
315
S 29 22%
To Dry Magnetic Separator
Non-Magnetic Concentrates
Magnetic Tailings
499 1 S-29 29%
185 9 parts
S-41 51%
Crushed
Screened
-6+20
-20
485 2 S-29 54%
320 9 S-28 85%
To Dry Magnetic Separator
Non-Magnetic Concentrates
Magnetic Tailings
345 S-25 27%
140 2 parts
S-40·05%
Crushed
Screened
-20+50
-50
301·5 S-27 19%
359 S-26 86%
To Dry Magnetic Separator
Non-Magnetic Concentrates
Middlings
Magnetic Tailings
165 4
S-27 05%
71 parts
S-39 41%
Crushed
65·1 parts
S-14 23%
Screened
-50+100
-100
185 1
S-29·00%
333 7 S-25 76%
To Dry Magnetic Separator
To Slime Table
Non-Magnetic Conc'tes
Middlings
Magnetic Tailings
Concentrates
Tailings
75·4
27 8 parts
S-40 19%
S-35 69%
81 9 parts
S-19 05%
183 7 S-32 45%
150 parts
S-17·55%
To Dry Magnetic Separator
To Wet Magnetic Separator
Concentrates
Tailings
Non-Magnetic Conc'tes
Magnetic Tailings
42·4 parts
S-39 23%
33 parts
S-31 12%
107 6 parts
S-40 82%
76 1 parts
S-20·65%
Final Combined Concentrates
574 8 parts-Analysis S-40 56%
Final Combined Tailings
406 2 parts-Analysis-S-19 00%
Samples Taken
19 parts-S-26 84%
Sulphur

Fig 15

GRAPHIC METHOD OF ILLUSTRATING CONCENTRATION TESTS FOR THE RECOVERY OF SULPHUR FROM PYRITES ORE

Test No. 31

NORTHERN PYRITES CO., NORTH PINES, ONT.

Middlings obtained, 51·5 lb.
Tailings " 56 lb. Analysis, 19·5% S.
The middlings were run over the separator with the tailing vane raised 3¼ inch.
Concentrates obtained, 29 lb. Analysis, 39·23 % S.
Tailings " 22·5 lb. " 31·12 % S.

Size—100, (—0·055). Weight 228 lb.—

A satisfactory separation could not be made by dry magnetic separation, so that table concentration on the Deister slime table followed by wet magnetic separation on the Ullrich magnetic separator was resorted to.

Deister concentrates obtained, 125·5 lb. Analysis, 32·45 % S.
Deister tailings " 102·5 lb. " 17·55 % S.

Concentrates were re-run on the Ullrich magnetic separator with a current strength of 10 amperes, 110 volts on the magnets.

Non-magnetic concentrates obtained, 73·5 lb. Analysis, 40·82 % S.
Magnetic tailings " 52·0 lb. " 20·65 % S.

The method of procedure, and the results obtained from the final run of the ore, are given in the following flow sheet. A graphic illustration showing the recovery from each operation, and the final total recovery of sulphur is also given.

Test No. 32.

A small sample of 4 pounds of zinc-lead-copper ore was received from Stanislas J. Pointon, Esq., of the Laurentide Mining Company, Notre Dame des Anges, county of Portneuf, Quebec.

Analysis of the sample showed it to contain:—

Zinc	21·30	per cent.
Lead	1·18	"
Copper	4·76	"
Insoluble	31·12	"
Silver	1·74	oz.

The sample was crushed to pass through 10-mesh and sized on the 16-, 20-, 30-, 40-, 60-, 80-, 100-, 150-, and 200-mesh screens. The sizes were run through the laboratory pneumatic jig, commencing at the coarser size, and following up with the finer sizes, without removing the jig bed. A fair separation was made on the sizes up to 100-mesh.

Analysis of the jig concentrate showed it to contain:—

Zinc	36·00	per cent.
Lead	1·08	"
Copper	6·97	"

Analysis of the jig tailing showed it to contain:—

Zinc	6·79	per cent.
Lead	0·26	"
Copper	1·44	"

The products from the above separation were mixed together and run over the laboratory Wilfley table. The concentrates from the Wilfley table were treated on the Huff electrostatic separator to obtain a separation of the copper values from the zinc values. It was found that the zinc particles, together with their iron content, were almost as conductive as the chalcopyrite particles. The separation was not satisfactory.

Further tests were not made, as there was such a small quantity of the material that it was impossible to do anything further with it.

From tests conducted on a similar ore, a possible concentration would be that of jig and table concentration, magnetic separation, and oil flotation of the table tailings.

TEST NO. 33.

THE MAGNETIC IRON SANDS, NATASHKWAN, SAGUENAY COUNTY, QUEBEC.

Concentration Tests.

Two shipments of magnetic iron sands were received at the ore testing laboratories, from Natashkwan, Quebec. These samples were taken during the summers of 1912 and 1913.

The method of obtaining these samples has already been described in the Summary Report of 1913. To enable the following tests to be more easily understood, a brief description of the method of obtaining the samples is given.

The deposits of magnetic iron sand situated at the mouth of the Natashkwan river were surveyed and blocked off into squares with 500-feet sides. Five holes were drilled in each square; one at each of the four corners and one in the centre. The core from each of these drill holes was bagged separately, numbered, and shipped to Ottawa. While the above sand was being bagged, a field sample was taken of each 5 feet of the core. The magnetic iron content of this sample was determined in the field by a hand magnet and a set of balances.

To check the accuracy of the field sample, the bags containing the cores of each bore hole were sorted out and separated. The core from each bore hole was dried separately, and its dry weight and volume in cubic feet were obtained. It was then run over a Gröndal dry magnetic separator, and the products were weighed up and the results checked with those obtained from field samples.

The Field Samples of 1912 were Tested First.

As stated above, the core from each bore hole was dried, and the weight and volume of the sand obtained. They were then run separately over a Gröndal dry magnetic separator.

The combined weight of the concentrates obtained from all the samples was 1,024 pounds, and that of the tailings, 19822·05 pounds.

ANALYSIS of first Concentrate and first Tailing obtained from the Gröndal Dry Magnetic Separator.

—	Fe.	FeO	TiO_2	SiO_2	Au.
	per cent.	per cent.	per cent.	per cent.	
Crude	6·75	....	....	....	....
First concentrate	64·12	....	2·40	7·64	....
First tailing	3·79	1·89	2·30	82·37	none.

It is very difficult to obtain an average sample of the dry sand. The concentrates were sampled on the Jones riffled samplers to approximately 10 pounds. One-half was taken for a screen analysis, and the other half for the regular sample. The tailings were sampled through Vezin samplers, to an amount small enough to cut down in the riffled sampler. Screen sizing tests were made on the tailings; one on a small sample of 3124·97 grams, using a set of Tyler standard screens after Rittenger's scale, and a larger one on a sample weighing 1747·50 pounds, using the Keedy sizer.

Grinding and reconcentration of the first concentrate.

The first concentrate from the cobber was ground in a Hardinge 4 × 6-inch conical mill and fed to a Gröndal double drum wet magnetic separator.

A screen analysis was made on the tube mill discharge and also on the final concentrate and tailing from the separator.

ANALYSES of First Concentrate, Second Concentrate, and Tailing.

——	Fe.	FeO	TiO_2	SiO_2	S.	P.	Mn.	CaO	MgO
	%	%	%	%	%	%	%	%	%
First concentrate.....	64·12	....	2·40	7·64	....	....	......	....	....
Second concentrate......	69·39	......	1·52	2·08	trace	0·008	0·043	trace	trace
Second tailing.........	26·50	5·52	7·57	56·14	......	....	....	....	......

Calculation of iron saved from second concentration—

$$\frac{69\cdot39 - 26\cdot55}{64\cdot12 - 26\cdot55} = 1\cdot141 \text{ tons of first concentrate required per unit of second concentrate.}$$

$$\frac{69\cdot39 \times 100}{64\cdot12 \times 1\cdot141} = 94\cdot8\ \% \text{ of the iron saved.}$$

Calculation of iron saved from analyses and actual weights.

Weight of first concentrate	1024	pounds.
" " second concentrate	902·1	"
" " " tailing	121·9	"

$$\frac{(902\cdot1 \times 69\cdot39)\ 100}{1024 \times 64\cdot12} = 95\cdot37.$$

SCREEN TEST OF FIRST CONCENTRATES: (Lot 1912) Showing distribution of Iron and Titanic Acid.

Mesh.	Aperture in inches.	Weight in grm.	Direct per cent of total weight.	Cumulative per cent of weight.	Iron per cent.	Distribution of iron per cent of total.	Cumulative per cent of total iron.	Titanic acid per cent.	Distribution of acid per cent total.	Cumulative per cent of total titanic acid.
+ 20	·0328	0·47								
− 20 + 28	·0232	2·87	0·73	0·73	12·31	1·42	1·42	2·13	0·71	0·71
− 28 + 35	·0164	13·21								
− 35 + 48	·0116	65·49	2·89	3·62	21·47	·98	2·38	3·08	4·10	4·87
− 48 + 65	·0082	235·24	10·39	14·02	43·27	7·03	9·41	3·65	18·28	22·51
− 65 + 100	·0058	673·25	29·74	43·75	63·63	29·63	39·10	2·53	34·98	57·53
− 100 + 150	·0041	1173·42	51·81	95·50	69·37	56·23	95·36	1·65	39·73	97·30
− 150 + 200	·0029	74·80	3·31	98·80	69·68	3·60	99·35	1·22	1·89	99·17
− 200 +	......	25·30	1·12	......	61·82	1·08	.... ..	1·72	·88	
Totals......	......	2264·05	99·99	......	....	99·99	......	......	....	......

NATASHKWAN IRON SANDS (1912).—Sizing Test using Tyler Standard Screens on Tailings from first concentration.

Mesh.	Aperture in inches.	Weight in grm.	Direct per cent.	Cumulative per cent.
+ 14	0·0460	26·93	0·86	0·86
− 14 + 20	0·0328	39·97	1·28	2·14
− 20 + 28	0·0232	101·21	3·24	5·38
− 28 + 35	0·0164	267·62	8·57	13·94
− 35 + 48	0·0116	1619·32	51·82	65·76
− 48 + 65	0·0082	675·85	21·63	87·41
− 65 + 100	0·0058	238·99	7·65	95·01
− 100 + 150	0·0041	130·13	4·16	99·22
− 150 + 200	0·0029	16·16	0·52	99·73
− 200 + 8	8	8·79	0·28	
Totals............	....	3124·97	99·99	

NATASHKWAN IRON SANDS (1912).—Keedy Sizer Test on Tailings from first concentration.

Mesh.	Screen No.	Aperture inches.	Weight in pounds.	Direct per cent.	Cumulative per cent.
20	20 SW	·0410	37·00	2·12	2·12
24	24 SW	·0342	29·50	1·69	3·80
28	28 SW	·0282	42·50	2·43	6·24
34	34 SW	·0229	60·00	3·43	9·67
42	42 SW	·0183	86·00	4·92	14·59
50	50 SW	·0145	258·00	14·75	29·35
62	4 XX	·0116	504·50	28·87	58·25
74	6 XX	·0089	428·50	24·52	82·73
86	8 XX	·0068	97·50	5·58	88·30
109	10 XX	·0054	143·50	8·21	96·50
125	12 XX	·0041	38·00	2·17	98·70
150	15 XX	·0036	....	....	....
200	25 Std.	·0026	18·00	1·03	99·78
....	—25 Std.	....	4·50	0·26	... .
Totals	....	....	1747·50	....	....

SCREEN TEST tube mill discharge grinding first concentrate: (Lot 1912) Showing distribution of Iron and Titanic Acid.

Mesh.	Aperture in inches.	Weight in grammes.	Per cent of total weight.	Cumulative per cent of total weight.	Per cent of iron.	Distribution of iron per cent of total.	Cumulative per cent of iron.	Per cent of titanic acid.	Distribution of titanic acid of total.	Cumulative per cent of titanic acid.
+ 28	·0232	0·34	·074	·074	60·24[1]	·07	·07	2·14	·065	·065
− 28 + 35	·0164	0·95								
− 35 + 48	·0116	0·70								
− 48 + 65	·0082	12·40	·46	·535	19·51	·14	·214	1·55	·31	·379
− 65 + 100	·0058	87·97	3·27	3·81	37·52	1·95	2·16	2·77	4·02	4·40
− 100 + 150	·0041	750·75	27·94	31·75	62·30	27·64	29·78	2·34	28·94	49·87
− 150 + 200	·0029	648·02	24·10	55·87	65·50	25·05	54·81	2·14	22·82	72·68
− 200	....	1186·85	44·16	....	64·50	45·15	....	2·24	43·80	....
Totals ...	... .	2687·98	100·00	....	....	.. ..	. ...	....	. .....	.. ...

---

[1] NOTE.—This high iron is due to pieces of iron from the tube mill.

SCREEN TEST of second concentrate: (Lot 1912).—Showing distributions of Iron and Titanic Acid.

Mesh.	Aperture in inches.	Weight in grammes.	Direct per cent of total weight.	Cumulative per cent of weight.	Iron per cent.	Distribution of iron per cent of total.	Cumulative per cent of total iron.	Titanic acid per cent.	Distribution of titanic acid, per cent of total.	Cumulative per cent of titanic acid.
- 48 + 65	·0072	2·27	0·23	0·23	55·64	2·40	2·40	2·83	5·77	5·77
- 65 + 100	·0042	27·29	2·73	2·956						
- 100 + 150	·0026	259·44	25·95	28·90	67·62	25·66	28·04	1·73	31·10	26·93
- 150 + 200	·0021	255·00	25·50	54·40	68·80	25·65	53·69	1·41	24·89	61·80
- 200	....	456·00	45·60	....	69·45	46·28	....	1·21	38·23	....
Totals ...	....	1000·00	100·00	....	....	....	....	... .	....	....

SCREEN TEST on second tailing: (Lot 1912). Showing distribution of Iron and Titanic Acid.

Mesh.	Aperture in inches.	Weight in grammes.	Direct per cent of total weight.	Cumulative per cent of total weight.	Per cent iron.	Direct per cent of total iron.	Cumulative per cent of total iron.	Per cent titanic acid.	Direct per cent of titanic acid.	Cumulative per cent of titanic acid.
+ 35	·0122	1·00	·10	·10	6·73	·305	·305	0·92	·15	·15
- 35 + 48	·0092	1·00	·10	·20						
- 48 + 65	·0072	10·00	1·00	1·20						
- 65 + 100	·0042	93·00	9·30	10·50	7·23	2·54	2·84	2·22	2·89	3·05
- 100 + 150	·0026	242·00	24·20	34·70	18·17	16·56	19·40	8·84	23·22	26·23
- 150 + 200	·0021	242·00	24·20	58·90	26·73	24·36	43·75	8·98	30·05	56·73
- 200	....	411·00	41·10	....	36·33	56·23	....	7·51	43·27	....

TEST ON FIELD SAMPLES, 1913.

The field samples representing each bore hole were dried, and run separately over a Gröndal cobber, as in the first test on the 1912 samples.

The combined weight of concentrate obtained from the above samples was 2,021·75 pounds, and the tailing 27,882·67 pounds.

ANALYSIS of first concentrate and first tailing from the Gröndal dry magnetic separator:

——	Fe.	TiO_2	SiO_2	Au.
	Per cent.	Per cent.	Per cent.	Oz.
Crude	9·60	....	....	
First concentrate..............................	64·61	2·36	6·35	
First tailing..	5·61	2·69	84·58 insol.	None.

The concentrate was sampled on Jones riffled samplers, and a sizing test was made, using Tyler standard screens. The tailing was passed through a Vezin sampler, and then cut down on the riffler. A small lot of 5,605·929 grams was sized on the Tyler screens, and a lot weighing 1,313·5 pounds was sized in the Keedy ore sizer.

Grinding and reconcentration of first concentrate.

The first concentrate from the cobber was ground in a Hardinge 4-foot × 6-inch conical mill, and fed to the double drum Gröndal wet separator. A screen analysis was made of the tube mill discharge, of the final concentrate, and of the final tailing from the separator.

ANALYSIS of first concentrate, second concentrate, and second tailing:—

—	Fe.	FeO	TiO_2	SiO_2	S	P	Mn	CaO	MgO
	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent
First concentrate..	64·61	....	2·36	6·35	....	....	....	....	
Second concentrate......	68·37	....	1·61	2·27	Trace.	·023	·19	·13	·145
Second tailing....	28·95	....	9·17	46·50	....	....	......	....	

Calculation of iron saved from second concentration—

$$\frac{68{\cdot}37 - 28{\cdot}95}{64{\cdot}61 - 28{\cdot}95} = \frac{39{\cdot}42}{35{\cdot}66} = 1{\cdot}106 \text{ tons of first concentrate per unit of second concentrate.}$$

$$\frac{68{\cdot}37 \times 100}{64{\cdot}61 \times 1{\cdot}106} = 95{\cdot}60 \text{ per cent of iron saved.}$$

Calculation of iron saved from analyses and actual weights—

Weight of first concentrate..	2021·75 lb.
" second "	1849·64 "
" " tailing....................	172·11 "

$$\frac{1849{\cdot}64 \times 68{\cdot}37}{2021{\cdot}75 \times 64{\cdot}61} = \frac{1306{\cdot}25}{1264{\cdot}60} = 96{\cdot}75 \text{ per cent of the iron was saved.}$$

SCREEN TEST of first concentrate: (Lot 1913) Showing distribution of Iron and Titanic Acid.

Mesh.	Aperture in inches.	Weight in grammes.	Direct per cent of total weight.	Cumulative per cent of weight.	Iron per cent.	Distribution of iron per cent of total.	Cumulative per cent of total iron.	Titanic acid per cent.	Distribution of acid per cent of total.	Cumulative per cent of total titanic acid.
+ 35	·0164	14·175	0·42	0·42	14·85	0·10	0·10	2·27	0·42	0·42
– 35 + 48	·0116	53·865	1·61	2·03	24·26	0·61	0·71	3·26	2·30	2·72
– 48 + 65	·0082	608·108	18·22	20·25	55·29	15·62	16·33	3·08	24·66	27·38
– 65 + 100	·0058	1,870·533	56·03	76·28	67·16	58·55	74·68	2·27	55·88	83·26
– 100 + 150	·0041	670·761	20·09	96·37	69·38	21·61	96·29	1·61	14·21	97·47
– 150 + 200	·0029	85·475	2·56	98·93	68·42	2·71	99·00	1·41	1·58	99·05
– 200	....	35·721	1·07	....	60·19	1·00	.....	2·03	0·95	.....
Totals......	....	3,338·638	100·00	......	64·49	100·00	....	2·28	100·00	......

NATASHKWAN MAGNETIC IRON SANDS (1913).

SIZING TEST, using Tyler Standard Screens on tailing from first concentration. (Lot 1913.)

Mesh.	Aperture in inches.	Weight in grammes.	Direct per cent.	Cumulative per cent.
+14	0·0460	51·5970	0·92	0·92
−14+20	0·0328	70·8750	1·27	2·19
−20+28	·0232	188·5275	3·36	5·55
−28+35	·0164	487·0530	8·69	14·24
−35+48	·0116	2965·1265	52·89	67·13
−48+65	·0082	1180·2105	21·05	88·18
−65+100	·0058	408·8070	7·29	95·47
−100+150	·0041	210·0735	3·75	99·22
−150+200	·0029	26.3655	0·47	99·69
−200	.....	17·2935	0·31	......
		5605·9290	100·00	

NATASHKWAN MAGNETIC IRON SANDS, (1913).

KEEDY SIZER TEST on tailings from first concentration. (Lot 1913.)

Mesh.	Screen No.	Aperture.	Weight in pounds.	Direct per cent.	Cumulative per cent.
20	20 SW	·0410	29·5	2·25	2·25
24	24 SW	·0342	25·5	1·94	4·19
28	28 SW	·0282	35·5	2·701	6·88
34	34 SW	·0229	47·0	3·578	10·46
42	42 SW	·0183	70	5·328	15·80
50	50 SW	·0145	204·0	15·53	31·32
62	4 XX	·0116	349·0	26·57	57·82
74	6 XX	·0089	268·0	20·41	78·30
86	8 XX	·0068	128·0	9·75	87·90
109	10 XX	·0054	113·9	8·60	96·61
125	12 XX	·0041	26·5	2·02	98·63
150	15 XX	·0036	....		...
200	25 Std.	·0026	15·0	1·14	99·80
−200	−25 Std.	....	2·5	·19	
			1313·5	100·00	

SCREEN TEST tube mill discharge grinding first concentrate (Lot 1913). Showing distribution of Iron and Titanic Acid.

Mesh.	Aperture in inches.	Weight in grammes.	Per cent of total weight.	Cumulative per cent of total weight.	Per cent of iron.	Distribution of iron per cent of total.	Cumulative per cent of iron.	Per cent of titanic acid.	Distribution of titanic acid per cent of total.	Cumulative per cent of total titanic acid.
+ 48	·0092	6·24	·19	·19	8·16	·024	·024	1·06	·09	·09
− 48+ 65	·0072	29·77	·92	1·11	19·35	·277	·302	2·53	1·06	1·16
− 65+100	·0042	233·28	7·20	8·32	56·23	6·320	6·61	2·90	9·54	10·70
−100+150	·0026	826·17	25·49	33·79	64·95	25·400	32·45	1·98	23·14	33·85
−150+200	·0021	1,280·10	39·49	73·25	65·87	40·650	73·05	2·10	37·97	71·86
−200	....	867·50	26·75	....	64·58	26·700	....	2·29	28·20	......
		3,243·06								

SCREEN TEST on second concentrate (Lot 1913). Showing distribution of Iron and Titanic Acid.

Mesh.	Aperture in inches.	Weight in grammes.	Direct per cent of of total.	Accumulative per cent of weight.	Iron per cent.	Distribution of iron per cent of total.	Cumulated per cent of total iron.	Titanic acid per cent.	Distribution of acid.	Cumulated per cent of acid.
+ 48	·0116	1·5	·15	·15	30·85	0·31	0·31	2·75	1·26	1·26
− 48 + 65	·0082	5·5	·55	·70						
− 65 + 100	·0058	41·00	4·10	4·80	60·00	3·57	3·88	3·02	8·12	9·38
− 100 + 150	·0041	321·00	32·10	36·90	68·74	32·06	35·94	1·87	39·38	48·76
− 150 + 200	·0029	243·00	24·30	61·20	69·75	24·63	60·57	1·41	22·48	71·24
− 200	....	388·00	38·80	....	69·95	39·43	....	1·13	28·76	....
	......	1000·00	100·00	......	......	100·00	....	......	100·00	....

SCREEN TEST of second tailing: (Lot 1913). Showing distribution of Iron and Titanic Acid.

Mesh.	Aperture in inches.	Weight in grammes.	Direct per cent of total weight.	Cumulative per cent of weight.	Per cent of iron.	Distribution of total iron.	Cumulative per cent of total iron.	Titanic acid per cent.	Distribution of total titanic acid.	Cumulative per cent of titanic acid.
+ 48	·0116	12·00	1·20	1·20	5·53	0·23	0·23	0·90	·12	·12
− 48 + 65	·0082	43·20	4·32	5·52	5·23	0·77	1·00	1·23	·59	·71
− 65 + 100	·0058	100·00	10·00	15·52	8·74	2·90	3·99	3·81	4·23	4·95
− 100 + 150	·0041	221·50	22·15	37·67	22·91	17·35	21·34	9·86	24·30	29·22
− 150 + 200	0029	215·00	21·50	59·17	30·50	22·42	43·76	12·56	30·10	59·25
− 200	......	408·30	40·83	....	40·30	56·25	....	8·98	40·75	....
		1000·00	100·00			100·00				

REPORT OF INVESTIGATIONS AT THE RESEARCH LABORATORY OF APPLIED ELECTRO-CHEMISTRY AND METALLURGY, QUEENS UNIVERSITY, KINGSTON, ONTARIO, FOR THE MINES BRANCH, DEPARTMENT OF MINES, CANADA. (YEAR 1914.)

Herbert T. Kalmus.

Throughout the year 1914, and during the early months of 1915, the investigations of the metal cobalt and its alloys, with reference to finding increased commercial uses for them, have been in progress. These researches have been undertaken for the Mines Branch by the writer, with a staff of assistants, at Queens University, Kingston.

Electro-plating with Cobalt.

A very extensive series of experiments on electro-plating with cobalt has been completed. A great many technical points in connexion with the plating of cobalt had not been investigated, although the corresponding investigations for nickel had been comparatively thorough. Before platers could adopt cobalt for commercial purposes on a considerable scale, a number of questions required definitely to be answered by experiments, such as:—

(1) Can cobalt be plated on iron, steel, brass, tin, German silver, lead, etc., in such manner as to yield as uniform, as adhesive, and as satisfactory a finished surface as nickel?

(2) Is cobalt plate harder than nickel plate?

(3) Is cobalt plate less corroded than nickel plate by ordinary atmospheric action?

(4) What bath is most suitable for the deposition of cobalt, when a heavy protective coating, which may be buffed to a superior finish, is required to be deposited in a minimum of time?

(5) Can a satisfactory cobalt bath be maintained at such an increased concentration as compared with the nickel bath, that plating from it may proceed with greater speed?

(6) Is the cobalt bath more or less troublesome than the nickel bath as regards crystallization, etc.?

(7) Should alkali, acid, or neutral baths be used for cobalt plating?

(8) Is the nature of the deposit improved by hardeners such as boric acid, citric acid, magnesium salts, etc.?

(9) How does the maximum current density at which cobalt may be deposited commercially compare with the maximum current densities used in the commercial deposition of nickel?

(10) What electromotive force had best be used for cobalt plating, using the bath found most suitable for a given class of work?

(11) How do cobalt anodes compare with nickel anodes as regards solubility, under the conditions of the plating bath?

(12) What are the relative current efficiencies of cobalt and nickel plating under the best conditions?

(13) How do the electrical conductivities of satisfactory cobalt and nickel plating solutions compare?

(14) Can cobalt be deposited to considerable thicknesses from any solution in commercial practice?

(15) What are the relative costs of cobalt and nickel plating?

A very large number of plating experiments were conducted by us for purposes outlined by the above questions, in connexion with which some sixteen different types of solutions or baths were employed and studied. Following is the list:—

Series 1. Simple cobalt-ammonium sulphate.
“ 2. Cobalt-ammonium sulphate with an excess of ammonium sulphate.
“ 3. Cobalt-ammonium sulphate with an excess of ammonium sulphate, to which is added citric acid.
“ 4. Cobalt-ammonium sulphate with ammonium chloride.
“ 5. Cobalt chloride with ammonium chloride.
“ 6. Cobalt-ammonium sulphate with boric acid.
“ 7. Cobalt-ammonium sulphate, cobalt carbonate, and boric acid.
“ 8. Cobalt sulphate, potassium citrate, and ammonium chloride.
“ 9. Cobalt phosphate with sodium pyro-phosphate.
“ 10. Cobalt-ammonium sulphate with magnesium sulphate.
“ 11. Cobalt sulphate, neutral ammonium tartrate, with the addition of tannic acid.
“ 12. Cobalt sulphate, potassium tartrate, and tartaric acid.
“ 13. Cobalt sulphate, sodium chloride, and boric acid.
“ 14. Cobalt sulphate, ammonium sulphate, magnesium sulphate with boric acid.
“ 15. Cobalt-ethyl sulphate, sodium sulphate, and ammonium chloride.
“ 16. Cobalt sulphate, ammonium sulphate, ammonium chloride, and boric acid.

Hundreds of plating experiments were tried, the full report on which is made in the paper (Part III) entitled, “Electro-plating with Cobalt.” A set of conclusions was drawn with regard to the experiments under each series, and from the conclusions of all the series the important facts were established that solutions IB and XIIIB were of extreme commercial interest. As a result, the writer, in co-operation with the Russell Motor Car Company of West Toronto, Ont., undertook a series of experiments under strict commercial conditions on these two solutions. These experiments continued through a period of months, and are reported in full in the paper above mentioned. Following are the conclusions with regard to these two solutions:—

SOLUTION I B.

$CoSO_4, (NH_4)_2 SO_4, 6H_2O.$

5 pounds salts; 6 gallons water; sp. gr. 1·050—neutral.

Conclusions.

1. Cobalt plates from these cobalt-ammonium sulphate solutions, on brass and iron are firm, adherent, hard and uniform, and may readily be buffed to a satisfactorily finished surface. They take a very high polish, with a beautiful lustre, which although brilliantly white, possesses a slightly bluish cast.

2. The specific electrical conductivity of these cobalt-ammonium sulphate solutions is very much higher than that of the corresponding nickel solutions.

3. All of these cobalt plates within the current density ranges described as satisfactory, are as smooth, adhesive and generally satisfactory as the best nickel plates.

4. Solution I B, which is a nearly saturated solution of $CoSO_4. (NH_4)_2 SO_4.$, containing 200 grams of $CoSo_4. (NH_4)_2 SO_4. 6H_2O$ to the litre of water, yields satisfactory cobalt deposits at all current densities up to 4 amperes per square decimetre (37·2 amperes per square foot). This very rapid plating was performed in a manner similar to that of common plating practice.

5. There is no nickel bath operating in the manner of the usual commercial plating procedure at anything like as high a current density as cobalt solution I B. More specifically, the allowable current density with which an adherent, firm, smooth, white, hard plate may be obtained with solution I B, without sign of pitting or peeling, and yet which may be readily and satisfactorily finished, is four times that for which the same results may be obtained with the fastest commercial nickel solutions.

6. Solution I B may be used for plating on the usual surfaces, including brass, iron and steel. No preliminary coating of copper is necessary when plating with these baths on iron and steel.

7. Solution I B may be used with a large proportion of rolled anodes without becoming acid or depleted in metal.

8. Solution I B does not change appreciably in cobalt content or in acidity when used over long periods of time at the high recommended current density.

9. The current efficiency of solution I B is extremely high at a current density of 1 ampere per square decimetre. The mean of our measurements, agreeing very well among themselves, gave a value of 98·0 per cent. The current efficiency of solution I B is as high at 3 amperes per square decimetre as is common for the best nickel solutions used in nickel plating practice at very much lower current densities. The average of three closely agreeing current efficiency measurements with solution I B, at 3 amperes per square decimetre was 90·5 per cent.

10. Solution I B, when operated slightly alkaline, yields plates which are greyish in colour, which peel, pit and show blisters. This solution, when operated acid, yields plates which, while fairly adherent, firm and smooth, are dark and freakish.

This bath should be run neutral, for these plates are adherent, firm, smooth, white, hard, yet easily buffed to an excellent finish.

11. Solution I B requires very little, if any, ageing to put it in condition, but yields satisfactory plates almost from the start.

12. The "throwing" power of solution I B is remarkably satisfactory.

13. The anodes in solution I B are remarkably free from a coating, such as characterizes nickel anodes.

SOLUTION XIII B.

Cobalt sulphate, $CoSO_4$	312·5 grams.
Sodium chloride, NaCl	19·6 grams.
Boric acid	Nearly to saturation.
Water	1,000 c.c.
Total bath, approximately	1·5 litres.

Conclusions.

1. Solution XIII B is the most completely satisfactory solution, for a great variety of purposes, which we have found. We know of no solution, plating with nickel, which begins to compare with solution XIII B for the range of work which it will do, and for the extreme high current densities at which it will operate. It is possible to get a plate in three minutes or less, with solution XIII B, which will stand all the usual physical commercial tests and which will buff as satisfactorily as a plate which has taken one hour from the usual nickel plating baths.

2. Cobalt plates from this simple cobalt sulphate solution in the presence of sodium chloride and boric acid (solution XIII B) on brass and iron, are firm, adherent, hard, and uniform, and may readily be buffed to a satisfactorily finished surface. They take a very high polish, with a beautiful lustre, which, although brilliantly white, possesses a slightly bluish cast.

3. The specific electrical conductivity of solution XIII B is much higher than that of the corresponding nickel solution.

4. Solution XIII B does not yield the best cobalt plate at low current densities, that is, in the neighbourhood of 0·50 to 1·0 ampere per square decimetre, which is a common range for nickel plating work. Solution XIII B begins to plate most satisfactorily at a current density in the neighbourhood of 3·5 amperes per square decimetre, and continues to give satisfactory plates at all current densities up to 26·4 amperes per square decimetre. This is equivalent to a current density of over 240 amperes per square foot, and even at this speed, the limit of the solution has not yet been reached.

5. All of these cobalt plates within the wide current density range described as satisfactory for solution XIII B, are as smooth, adhesive and generally satisfactory as the best nickel plates.

6. Solution XIII B does not change appreciably in cobalt content or in acidity when used over long periods of time at current densities as high as 1 ampere per square decimetre. It only showed a very gradual diminution in cobalt content under the most severe conditions of the ageing test described above. We know of no other cobalt solution and of no nickel solution which would stand up under the conditions of this ageing test.

7. There is no nickel bath of which we are aware operating in the manner of the usual commercial plating procedure at anything like as high current density as solution XIII B.

8. Solution XIII B may be used for plating on brass, iron and steel, for which cathodes the above conclusions apply.

9. Solution XIII B may be used to deposit a heavy cobalt plate. These plates may apparently be deposited to any desired thickness, and they are firm, adherent, massive, of extreme hardness and show no tendency to curl or split.

10. Heavy plates may be obtained from solution XIII B to much better advantage than from solution XV[1] which has been patented for the purpose with nickel, that is, heavy deposits may be obtained from solution XIII B at current densities of 5 or 6 amperes per square decimetre, whereas solution XV must be operated at low current densities in the neighbourhood of 0·30 amperes per square decimetre. If a current density of above 6 amperes per square decimetre is used with solution XIII B for heavy deposits, under the conditions and dimension of our baths, it was found that trees were formed on the cathode.

11. Our experiments show that solution XIII B "throws" very satisfactorily.

12. Among the satisfactory properties of this remarkable solution should be mentioned an extremely high current efficiency, which we found at 1·0 and 5·0 amperes per square decimetre to be almost 100 per cent.

13. Solution XIII C, which is the nickel analogue of solution XIII B, yielded satisfactory plates up to about 5 amperes per square decimetre, but showed splitting at current densities greater than that. Nickel solution XIII C does not possess the remarkable qualities of its cobalt analogue XIII B, although in many respects it is an improvement on standard nickel solutions.

14. Solution XIII B requires very little ageing: it operates satisfactorily almost from the start.

15. Solution XIII B is so remarkable in its properties that it was thought highly worth while to develop it further under commercial conditions. See commercial tests, page 136.

Mr. Walter S. Barrows, foreman of the plating department of the Russell Motor Car Company, made a report to the writer in connexion with these two solutions as follows:—

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[1] Cobalt ethyl sulphate, 100 g.; Sodium sulphate, 10 g.; Ammonium chloride, 5 g; Water, 1,000 cc. G. Langbein & Co., D. R. P. 134736, Sept. 18, 1902.

REPORT OF MR. BARROWS ON SOLUTION I B.

"After preparing a cobalt plating solution according to your formula for bath I B, and having used this bath daily during the past eight weeks, plating a great variety of copper, brass, iron, steel, tin, German silver, lead, and Britannia metal articles of different shapes and sizes under exactly the same conditions as met with in general nickel plating at the factory of the Russell Motor Car Company, West Toronto, and after regarding the characteristics of this particular solution absolutely from a commercial viewpoint, I can heartily confirm any statement you have made to me regarding this remarkable solution. This bath was equipped with cobalt anodes, 98·75 per cent cobalt, which were sent to me from your laboratory.

"The runs made have varied from five minutes to 24 hours, and in each case the bath has proved wonderfully efficient.

"The cobalt plates obtained were smooth, white and fine grained, very adherent and uniform. In fact the surfaces of these deposits after several hours' run were so very smooth and uniform that a 4-inch cotton buff coloured them to a mirror finish quite easily. We use 14-inch and 16-inch buffs to colour 3-hour deposits of nickel.

"To test the hardness of the cobalt as compared with nickel, with reference to either buffing or polishing with emery, we plated strips of brass, one-half the surface with cobalt and one-half with nickel, always giving the nickeled portion the thickest plate. Then buffing or polishing across the two deposits we found invariably that the nickel was removed from the brass before the cobalt, and in some cases in one-half the time.

"Though so hard and firm, these plates colour beautifully with little effort, and require the use of much less buffing composition than comparatively thin plates of nickel. Automobile parts of irregular shape were plated from 10 to 20 minutes, and finished on a 6-inch buff operated at 3,000 r.p.m. without the slightest evidence of a defect in the plating. To accomplish this with our fastest nickel baths would require at least 60 minutes of plating.

"As a protective coating for iron or steel surfaces, I am convinced that a comparatively thin plate of cobalt will prove equally as effective as a thick plate of nickel from an ordinary double sulphate nickel bath, and the time and power required for the production of such plates is decidedly in favour of the cobalt.

"The deposits are also very adherent, no difficulty having been experienced in this respect, although tests were made repeatedly by bending, hammering and burnishing.

"One of the weak points of several so-called rapid nickel plating solutions which we have tried commercially, is their poor "throwing" powers: i.e., they do not deposit the nickel readily in the indentations or cavities of the cathode. The cobalt solution I B meets this requirement in a most efficient manner, the deposits on the distant portions of the cathode withstand the tests imposed in every case.

"Another most important feature of this solution, which should commend itself to every practical plater and manufacturer of plated wares, is the extremely high current density at which this solution may be employed without danger of pitting the plated surface. I have plated with this cobalt solution I B satisfactorily and under commercial conditions, at a current density of 42 amperes per square foot. This is 4·2 times the speed of our fastest commercial nickel solutions.

"As a further test we plated steel tubes of 1-inch diameter (2·5 cm.) for two hours, with a current density of 27 amp. per square foot, and then drew the tubes down to 0·625 inch diameter without injuring the deposit. Though extremely hard, the ductility of the deposited metal proved remarkable.

"All of our tests have been made in a still solution, without agitation of any kind, and the plates were subjected to the most severe treatment considered practical for high-grade metallic coatings on the various metals heretofore mentioned.

"We are also of the opinion that the anodes in the cobalt bath IB will remain free from coatings, such as characterize average anodes used in nickel baths, and that the cost of maintenance will be practically nothing compared to double sulphate nickel solutions.

"I can assure you that my experience thus far with these cobalt solutions has been intensely interesting, and I sincerely believe that their use commercially would revolutionize the art of electro-plating such wares as are now nickel plated.

"The simplicity of its composition, its self-sustaining qualities, the remarkable speed of deposition, together with the several points mentioned previously, should appeal to the commercial requirements of this progressive age."

Report of Mr. Barrows on Solution XIII B.

"After thoroughly testing cobalt plating bath XIII B, made according to your formula, I take pleasure in submitting the following report.

"I found the bath very simple to prepare, and at once began to operate the solution with high current densities. The results obtained were exceedingly gratifying. Evidently bath XIII B will require no prolonged ageing treatment, as splendid, white, hard, perfect deposits were obtained with extremely high current densities within three hours after bath was prepared.

"The experiments have been varied and the tests of plates severe and deliberate, the results have invariably been such as to cause me to regard cobalt bath XIII B the greatest achievement in modern electroplating improvements.

"The operation of the bath is positively fascinating; the limit of speed for commercial plating is astonishing, while the excellence of the plates produced is superior to those of nickel for many reasons.

"The efficiency of the freshly prepared solution, together with the self-sustaining qualities of the bath are without a parallel in any plating solution of any kind I have ever used.

"Thin embossed brass stampings were plated in bath XIII B for only one minute, then given to a buffer who did not know the bath existed and who was accustomed to buffing 1½ hour nickel deposits on these same stampings. This man buffed the cobalt plates upon a 10-inch cotton buff wheel revolving at 3,000 r.p.m. The finish was perfect, with no edges exposed. These stampings have been plated in two dozen lots for one minute, and from a total of 500 stampings we have found but three stampings imperfect after buffing. Each stamping is formed to a spiral after finishing, without injury to the deposit. Grey iron castings with raised designs upon the surface were plated one minute in cobalt bath XIII B, then burnished with 400 pounds of one-eighth inch steel balls for one-quarter hour without the slightest injury to the cobalt coating, as was proven by a 36-hour immersion in 15 ounces of water acidulated with 1 ounce of sulphuric acid.

"While attempting to reach the limit of current densities which would be practical with this bath XIII B, I have plated brass automobile trimmings with a current density of 244 amperes per square foot. These pieces were plated in lots of six, and a total of 100 were plated, buffed and ready for stock in one hour's time. No unusual preparation was made for the run, and the work was performed by one man. Size of piece plated, 1½-inch by 5 inches.

"Automobile hub-caps were plated three minutes in cobalt bath XIII B and buffed to a beautiful lustre of deep rich bluish tone by use of a 7-inch cotton buff revolving at 1,200 r.p.m. The deposits were ample for severe treatment usually received by such articles. Comparative tests of these deposits were made as follows: Same style castings plated in double sulphate nickel solution one hour were suspended as anodes in a solution of equal parts muriatic acid and water, sheet lead cathodes were used and a current of 200 amperes at 10 volts passed through the bath. The nickel was removed from the castings in thirty seconds, while forty-five seconds' time was required to remove the cobalt plates.

"The above mentioned plating tests were made with still solution, no form of agitation being employed. By aid of mechanical agitators these current densities could be greatly exceeded with highly satisfactory results.

"These cobalt plates were very hard, white and adherent and coloured easily with slight effort.

"Several plates were produced upon sharp steel surgical instruments. These instruments finished perfectly and, owing to the hardness of the cobalt plate, only a thin deposit was required to equal the best nickel deposits which we received as samples. Cobalt deposits should prove especially valuable for electroplating surgical instruments for this reason, non-adherent thick deposits being very dangerous for this class of work.

"Owing to the unusual mild weather in this locality during the past month, I have not concluded test with cobalt plates on highly tempered nickel-steel skate blades, but judging from appearances and various severe indoor tests we do not hesitate to report success in this direction. A three minute deposit from bath XIII B resists corrosion equally as long as a one-hour nickel deposit, the finish is even superior to nickel, while every test employed during the process of manufacturing the nickel-plated article has proved equally ineffective with cobalt plates, therefore, by reason of the effectiveness of thin cobalt deposits we believe cobalt plates should prove wonderfully efficient on skates, or any keen edged tool requiring a protective metallic coating.

"The runs made with bath XIII B have varied from 1 minute to 15½ hours, and in each case the results were remarkable. Electrotypes were reproduced one-sixteenth inch thick. Electro-dies were faced with cobalt one-eighth inch thick, the electrotypes being graphite covered wax and lead moulds, while the dies were made on oxidized silver-faced Britannia metal.

"The deposits from cobalt bath XIII B were very adherent and pliable, by proper regulation of the current beautiful white, hard, tough plates may be produced quickly on any conducting surface.

"The 'throwing' powers of cobalt bath XIII B makes possible its employment for plating deeply indented or grooved articles, such as reflectors, channel bars or articles with projecting portions.

"We also obtained the best plates with extremely high current densities, although plates finished with 75 amperes per square foot were of good colour and easily buffed. The production of excellent plates with a current density of 150 amperes proved particularly easy and densities in this neighbourhood were employed for the greater portion of our tests.

"Cobalt bath XIII B will produce excellent hard, white, tough plates absolutely free from pits or blemish at a current density of 150 amperes per square foot and under ordinary commercial conditions. This is fifteen times the speed of our fastest commercial nickel solution.

"Furthermore, the anode tops and hooks remain free from creeping salts. The solution retains its original clean appearance and the anodes dissolve satisfactorily, no slime or coating formed, brushing or cleaning anodes therefore will be unnecessary. The anodes used with this bath were 98·75 per cent cobalt which were sent me from your laboratory. The bath at the commencement of our tests was strongly acid to litmus, and has remained unchanged throughout our experiments. The specific gravity of the solution when freshly prepared was 1·24 and is the same to-day.

"The rich deep bluish-white tone of the cobalt plates upon polished brass surfaces is particularly noteworthy. This feature should assist greatly in making cobalt deposits very popular for brass fixtures, trimmings and plumbers' supplies.

"My experience with cobalt bath XIII B is by no means at an end. I intend to continue to use it until present supplies are exhausted and then equip a larger bath if supplies are obtainable. As a commercial proposition I am satisfied it is wonderfully efficient and economical.

"Taking into account the difference in cost of cobalt as compared with nickel, I am satisfied the metal costs for plating a given quantity of work with cobalt would be considerably less than for nickel plating a like quantity.

"Furthermore, the use of cobalt bath XIII B equipped with automatic apparatus for conveying parts through the bath would reduce the labour cost 75 per cent, such apparatus would be practical for a greater variety of wares than is now the case with nickel.

"We cannot speak too highly of cobalt bath XIII B, and confidently believe its future history will surpass the history of any electro-plating bath now in general use.

"In conclusion, please accept my warmest congratulations upon your successes with cobalt solutions, and heartily appreciating the opportunity of testing these solutions, I desire to sincerely thank you, kind sir, for the benefits derived therefrom."

From these commercial tests on cobalt plating, the following general conclusions may be drawn:—

1. Several cobalt solutions were found to be suitable for electro-plating with cobalt under the conditions of commercial practice. Best among these are the following:—

SOLUTION I B.

Cobalt-ammonium sulphate, $CoSO_4\ (NH_4)_2\ SO_4\ 6H_2O$, 200 grams to the litre of water, which is equivalent to 145 grams of anhydrous cobalt-ammonium sulphate, $CoSO_4\ (NH_4)_2\ SO_4$, to the litre of water. Sp. gr. = 1·053 at 15° C.

SOLUTION XIII B.

Cobalt sulphate, $CoSO_4$	312 grams.
Sodium chloride, NaCl	19·6 "
Boric acid	Nearly to saturation.
Water	1,000 c.c

Sp. gr. = 1·25 at 15° C.

2. Cobalt plates from these solutions, on brass, iron, steel, copper, tin, German silver, lead and Britannia metal articles, of different shapes and sizes, deposited under conditions identical with those met with in general nickel plating practice, are firm, adherent, hard and uniform. They may readily be buffed to a satisfactorily finished surface, having a beautiful lustre, which, although brilliantly white, possesses a slightly bluish cast.

3. The electrical conductivity of these solutions is considerably higher than that of the standard commercial nickel solutions, so that other things being equal, they may be operated at a lower voltage for a given speed of plating.

4. Solution I B is capable of cobalt plating on the various sizes and shapes of objects met with in commercial practice at a speed at least four times that of the fastest satisfactory nickel solutions.

5. Solution XIII B is capable of cobalt plating on the various sizes and shapes of objects met with in commercial practice at a speed at least fifteen times as great as that of the fastest satisfactory nickel solutions.

6. Plates from both of these solutions on various stock pieces, satisfactorily withstood the various bending, hammering and burnishing tests to which the commercial nickel work is ordinarily submitted.

7. These two very rapid cobalt solutions are remarkable for their satisfactory throwing power. That is, they readily and satisfactorily deposit the cobalt in the indentations of the work.

8. These two very rapid solutions operate at these high speeds in a perfectly still solution without agitation of any kind.

9. These solutions are both cleaner, that is freer from creeping salts and precipitated matter, than the standard commercial nickel baths.

10. The cobalt deposited at this rapid speed is very much harder than the nickel deposited in any commercial nickel bath. Consequently a lesser weight of this hard cobalt deposit will offer the same protective coat as a greater weight of the softer nickel deposit. Considering solution XIII B, operating at 150 amperes per square foot, on automobile parts, brass stampings, etc., etc., a sufficient weight of cobalt to stand the usual commercial tests, including buffing and finishing, is deposited in one minute. With the best nickel baths, it takes one hour, at about 10 amperes per square foot, to deposit a plate equally satisfactory. Therefore, the actual weight of metal on the cobalt plate must be approximately one-fourth that of nickel.

11. For many purposes, under the condition of these rapid plating solutions, one-fourth the weight of cobalt, as compared with nickel, is required to do the same protective work. Consequently, if nickel is worth 50 cents a pound in the anode form, cobalt would be worth nearly $2 a pound in the same form, to be on the same basis, weight for weight of metal. In addition, there are other advantages of cobalt in saving of labour, time, overhead, etc.

12. A smaller plating room would handle a given amount of work per day with cobalt than with nickel.

13. With these very rapid plating solutions, by the use of mechanical devices to handle the work, the time required for plating, as well as the labour costs may be tremendously reduced. Solution I B, and particularly Solution XIII B, are so rapid as to be revolutionary in this respect.

14. Obviously the cost of supplies, repairs, etc., would be less with cobalt-plating than with nickel-plating, as the size of the plant for a required amount of work is less.

15. The voltage required for extremely rapid cobalt-plating is greater than that for most nickel-plating baths; it is not so great but that the machines at present in use may in general be operated. For the same speed of plating, the cobalt solution requires much the lower voltage.

16. For a given amount of work the power consumption for this rapid cobalt work is less than that for nickel This is obvious, because the total amount of metal deposited in the case of cobalt is very much less, whereas the voltage at which it is deposited is not correspondingly greater.

17. Ornamental work on brass, copper, tin, or German silver would require only a one-minute deposit. Even wares exposed to severe atmospheric influences, or friction, could be admirably coated with cobalt in solution XIII B in fifteen minutes. The

tremendous possibilities of this solution are not to be completely realized unless mechanical devices are applied to reduce hand labour to a considerable extent.

18. Thick deposits from these solutions are vastly superior to any that we have seen produced from nickel solutions. The tendency to distort thin cathodes is less pronounced, while electrotypes and electro-dies have been given a superior thick deposit in a most satisfactory manner. The lines were hard, sharp and tough and the surface smooth. Nickel does not equal cobalt for excellence of massive plates.

19. Many of these tests were passed upon by uninterested skilled mechanics at the plant of the Russell Motor Car Company, who invariably reported in favour of the cobalt as above.

20. Both solutions IB and XIIIB are substantially self-sustaining, once they are put into operating condition, and the amount of ageing required to do this is very much less for them than that for the present commercial nickel baths.

A number of automobile parts, and a large number of skates, cobalt plated, were turned out at the plant of the Russell Motor Car Company under Mr. Barrows' direction, and many of the skates have now (February 6, 1915) been under observation in actual use for several months.

On this date Mr. Barrows reported that skates plated from solution XIII B, many of which had had extremely hard usage in the hands of boys, etc., were showing up with surprising satisfaction.

There is absolutely no stripping of the plate along the edge of the skate, either before or after use, which unfortunately is not uncommon with nickel-plated skates. Furthermore, the cobalt-plated skates seem to be decidedly superior to the nickel-plated skates as regards their resistance to corrosion. Another very noticeable feature about the cobalt-plated skates is that they are very free from scratches after rough usage as compared with nickel. That is to say, the cobalt plate is decidedly harder than the nickel plate. Most of the skates in question were plated in three minutes at 90 to 100 amperes per square foot. Nickel plates at the same plant are plated in one hour at about 4 amperes per square foot.

There is apparently considerably more cobalt metal plate on these skates than need be to make them equivalent to nickel-plated skates.

MAGNETIC PROPERTIES OF COBALT AND OF Fe_2Co.

A series of experiments were conducted on the magnetic properties of cobalt and of Fe_2Co. These experiments are only just being completed, and include investigations under the following headings:—

1. Permeability of pure cobalt.
2. Hysteresis of pure cobalt.
3. Magnetic properties of the alloy Fe_2Co.

Magnetic constants of pure cobalt were studied by two independent methods, and the results should establish the values of these properties with considerable accuracy.

The greatest difficulties were experienced in obtaining sound castings of the compound Fe_2Co. The smallest quantities of occluded gas naturally caused extreme variations in the values of the magnetic constants determined. The results, therefore, with regard to this alloy are somewhat uncertain as regards commercial reproducibility, although our results, in connexion with those of Professor Pierre Weiss, of Zürich, Switzerland, establish the fact that this compound has a magnetic permeability between 5 and 10 per cent greater than that of the best Swedish soft iron. All of these experiments will be reported during the coming months in a paper entitled "Magnetic Properties of Cobalt and of Fe_2Co," by Herbert T. Kalmus and Kenneth B. Blake.

COBALT ALLOYS WITH NON-CORROSIVE PROPERTIES.

Since it is impossible to be certain *a priori* what effect the addition of any metal will have on the properties of another, and as it has been shown that certain metals in small quantities improve the resistance of iron to atmospheric corrosion, these investigations were undertaken for the purpose of determining the effect of the addition of small quantities of cobalt on the atmospheric corrosion of iron and mild steel. We have particularly in mind the addition of small quantities of cobalt to the very pure iron prepared by the open hearth method for sheet roofing material.

The comparative effects of small amounts of cobalt, nickel and copper were studied.

Our interest was stimulated by the positive nature of certain very early preliminary experiments, described in the next paragraph.

PRELIMINARY EXPERIMENTS.

Very early in the course of these investigations on cobalt and its alloys, in the autumn of 1912, a preliminary set of alloys was prepared by adding small percentages of both cobalt and nickel to very pure iron. These alloys were exposed for several months on the roof of Nicol Hall, Queens University, Kingston, Ontario. After this exposure they were removed, and the amount of corrosion determined. In every case it was found that the addition of small percentages of cobalt and nickel had decreased the corrosion of the pure iron.[1]

Following this, a second set of alloys was made with the same materials, in the same way, and exposed under the same conditions as the previous set, for a period from June 16, 1913, to October 16, 1913. At the end of this exposure of 122 days, the alloys were taken in, and the rate of corrosion in grams per square centimetre of exposed surface per year was computed.

Unfortunately, two of the alloys of this set were spoiled during the exposure, owing to dropping from the supports and coming in contact with the metal roof, so that the series is not sufficiently complete to warrant giving all the details. However, the results were in general accord with those of the previous set, which led us to believe that the addition of cobalt in proper proportions to pure iron might prove of benefit to its non-corrosive properties.

The general method of procedure with these preliminary experiments was the same as that described in detail for the complete sets of experiments to be described below.

The two sets of experiments above described must be considered preliminary for a number of reasons, primarily because no heat treatment was given to the alloys.

CONCLUSIONS.

1. From these preliminary experiments, additions of small percentages of both Co and Ni to American ingot iron seemed to add to its non-corrosive property.
2. Cobalt seemed to be more effective than nickel when used in like amount.
3. These results were such as to stimulate further interest, but were not sufficiently complete or satisfactory to warrant definite conclusions.

As a result of these preliminary experiments three series of alloys were made and exposed, containing various percentages of cobalt, nickel and copper and combinations of these in American ingot iron, from 0·25 per cent to 3 per cent of the elements mentioned. These alloys were prepared very nearly carbon free, and also containing small amounts of carbon.

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[1] The "pure" iron was American Ingot Iron, supplied by the American Rolling Mill Company, Middletown, Ohio.

Series 1 was exposed on the roof of Nicol Hall from March 18, 1914, to August 31, 1914, an exposure of 3,984 hours. In addition to analyses of the various alloys, their diameter, thickness, and weight of the exposed disc, both before and after exposure were measured, and the loss in weight in grams per square centimetre of original surface per square hour of exposure computed from these measurements.

A second complete series consisting of about 20 alloys was prepared. This series was a check on the first series, and was exposed on October 10, 1914. A record of analysis, dimensions, etc., was made, but the final measurements have not been made, as these samples are still corroding.

On December 22, 1914, a third complete set of alloys, about 100 in number, was exposed in a manner similar to that of the first two series. The alloys of Series 3 were prepared, paying particular attention to the heat treatment. The final measurements of this series have not yet been made, as the alloys are still being exposed to atmospheric corrosion.

In addition to these series, in co-operation with the American Rolling Mills Company, Middletown, Ohio, who are producing large quantities of American ingot iron for sheet roofing purposes, a number of 8 foot sheets of American ingot iron with various percentages of cobalt were prepared. Some of these sheets are being exposed at the plant of the American Rolling Mills, Middletown, Ohio, and others are being exposed on the roof of Nicol Building, Queens University, Kingston, in company with the samples of the three series mentioned. These sheets have been regularly photographed from time to time and observations as to their condition, etc., made.

In connexion with the preparation of these three sets of alloys about 30 microphotographs have been taken, illustrating the intimate structure of the alloys in question.

All these facts in detail, together with the complete data, will be published by the writer during the coming months in a bulletin of the Mines Branch under the title, "Cobalt Alloys with Non-corrosive Properties."

Cochrome Wires—A Comparison with Nichrome.

Under this heading a paper will appear during the coming months by Herbert T. Kalmus and Kenneth B. Blake, setting forth a series of experiments in which cobalt-iron-chromium-manganese wires were prepared, analogous to the well-known nichrome, for comparison with the latter for use as heating elements. The comparative properties of these wires were studied under the following headings—hardness, brittleness, tensile strength, electrical resistance cold, temperature co-efficient of electrical resistance, oxidation at high temperatures, and melting point. The work on these wires is not yet completed and the conclusions may be distinctly modified before final publication is made. The preliminary conclusions which may be drawn from the experiments thus far are as follows:—

1. *Mechanical Properties.*—The cochrome wires of the compositions represented by the five samples measured do not depart widely from nichrome wires as regards mechanical properties. These cochrome wires may be swaged with about the same ease as nichrome. They are slightly harder, and samples A B 19 and A B 20 have a higher tensile strength than nichrome. There is very little difference in the brittleness of the two types of wire.

2. *Electrical Properties.*—The specific electrical resistance of the various members of this cochrome series at room temperature is from 0·5 to 0·6 that of nichrome under the same conditions. The lowest value for cochrome which we have found is 60·5 microhms per cm. cu., and the highest value 74·9 microhms per cm. cu., as against 110 microhms per cm. cube for nichrome.

The specific resistance of cochrome and nichrome approach one another as the temperature is raised from room temperature. The temperature co-efficient of resistance for cochrome varies between 0·00065 and 0·00085 per degree C., whereas the corresponding value for nichrome is 0·00052. These values are mean temperature co-efficients between 20° and 1,000° C., and while not very accurate are fairly comparative.

The current carrying capacity is approximately the same for cochrome and nichrome wires of the same size.

3. *Oxidation at High Temperatures due to Electric Current.*—Cochrome wires which we have studied oxidize much more readily than nichrome wires at the same temperature, when heated by an electric current. The temperature range which we particularly studied was from 900° C. to 1,200° C.

4. *Corrosion in Acids.*—Nichrome is less attacked by 20 per cent H_2SO_4 than is cochrome under the conditions of our experiments.

5. *Melting Temperatures.*—The melting temperatures of the cochrome varies from 1293° to 1379° C., all of them being lower than that of nichrome, which we found to be 1380° C.

6. *Properties for use as Heating Element.*—Cochrome is inferior to nichrome for most purposes for which these wires might be used for winding heating coils. The principal disadvantage is that of increased oxidation at temperatures from 900° to 1,200° C. The high temperature co-efficient of resistance of cochrome, as compared with nichrome, tends to equalize their resistances with increasing temperature. For most purposes it annuls the advantages of cochrome due to its lesser specific resistance at low temperatures. It might find special application at intermediate temperatures because of its lower resistance, or it might find special application in atmospheres other than oxidizing ones.

The work of this laboratory, on cobalt, has stimulated a variety of interests to experimenting in various directions, and, as well, has had a direct influence upon the consumer of the metal cobalt, both for the preparation of alloys and in the plating industry. Inquiries of an important commercial character from manufacturing purchasers have repeatedly come to the attention of the writer, and the indications from a variety of sources are for a distinctly increased market for metallic cobalt.

FUELS AND FUEL TESTING DIVISION.

I.

WORK AT FUEL TESTING STATION.

B. F. Haanel.

Chief of Division.

The work of the Division of Fuels and Fuel Testing during the year 1914 consisted in the investigation of eleven commercial samples of coal, in the experimental boiler provided for that work—the installation of which was completed early in the year—and the testing in the gas producer of five samples of coal. The coals tested for steaming purposes were obtained from the following mines: Cardiff Collieries, Ltd.; Gainford Coal Co., Ltd.; Twin City Coal Co., Ltd.; Tofield Coal Co., Ltd.; The Rosedale Coal and Clay Products, Ltd.; Yellowhead Pass Coal and Coke Co., Ltd.; Drumheller Coal Co.; Newcastle Coal Co., Ltd.; Canmore Coal Co., Ltd.; Jasper Park Collieries, Ltd.; and the Pembina Coal Co., Ltd. The coals tested in the gas producer were the following: Pembina Coal Co., Ltd.; Drumheller Coal Co., Ltd.; Jasper Park Collieries, Ltd.; and the Newcastle Coal Co., Ltd. The coals on hand at the beginning of the new fiscal year—which will be investigated during the following season—are: Georgetown Collieries, Ltd.; McGillivray Creek Coal and Coke Co., Ltd.; West Canadian Collieries, Ltd.; Franco-Canadian Collieries, Ltd.; Greenhill Mine, West Canadian Collieries, Ltd. In addition to these commercial samples, the detailed investigation of which involved much chemical work, the chemical laboratory received for analysis, proximate, ultimate, or both, and determination of heating value, the following samples: Ninety-five coals, thirty-four peats, eleven oils or oil sands, seven ashes, four natural gases, and six miscellaneous samples. The work of the chemical laboratories is increasing at a rapid rate, and the staff, as a consequence, is scarcely able to keep up with the routine work.

With a view to rendering assistance to the coal operators of the Dominion of Canada in their efforts to reduce the mine accidents due to explosions resulting from mine gas, the Mines Branch undertook to analyse samples of gas from all the mines operating in the various provinces. Arrangements have been made whereby the chief inspectors of those provinces affected can furnish samples of mine gas, in specially constructed sample flasks furnished by the Mines Branch. Instructions were issued, explaining in detail how the sample should be taken and mailed to this office. The laboratory of the fuel testing station is now equipped with the special apparatus required for this class of work, and up to the close of the year we had received several samples from British Columbia, Alberta, and Nova Scotia.

The machine shop was kept exceedingly busy constructing new pieces of apparatus and machinery for the ore concentrating laboratory, the fuel testing station, and the laboratories of the main building of the Mines Branch, Sussex street, Ottawa. The subjoined report of the mechanical superintendent of the fuel testing station shows, in detail, the class of work performed for the various laboratories; the time of labourer or machinist spent on the individual pieces of work; and the cost of both labour and material. The labour charges account only for the time of the labourer while employed in the machine shop, not for his time in other work required to be done in the laboratories. An examination of the report will show that very decided economies have resulted in both the repair of old and construction of new apparatus, which, heretofore, had to be done outside, in the various machine shops.

The office work during the year consisted in the preparation of the report entitled, "Peat, Lignite, and Coal:, Their Value as Fuels for the Production of Gas and Power in the By-Product Recovery Producer," and the final report on the results of the large scale tests which were conducted and completed this year.

The writer, during the month of August, was instructed to witness the test of the Johnson Electric Zinc Smelter at Hartford, Conn., in conjunction with Mr. G. C. Mackenzie, Chief of the Division of Ore Dressing and Metallurgy. This work necessitated the writer's absence from Ottawa during the month of August.

In October, the writer visited the Chief Inspector of Mines for the Province of Alberta, in order to confer on the arrangements for future shipments to Ottawa of coal for testing purposes. On this trip, he obtained samples of oil from the Calgary oil fields, which are now being investigated at the laboratories of the fuel testing station.

In addition to the regular work of this division, the writer and Mr. J. Blizard were engaged for some time in the investigation and writing of a report on the Graham process for the manufacture of peat fuel.

During the latter part of the year, the staff of the Division of Fuels and Fuel Testing was increased by the permanent appointment of Messrs. J. H. H. Nicholls and T. W. Hardy to the chemical laboratories, and E. S. Malloch, B.Sc., as additional technical engineer to the division.

Toward the close of the year, an experimental briquetting press was purchased for the purpose of investigating the feasibility of briquetting western lignites, which will shortly be undertaken.

The summary reports of Messrs. Stansfield, Mantle, and A. von Anrep are herewith subjoined.

II.

CHEMICAL LABORATORIES OF FUEL TESTING STATION.

EDGAR STANSFIELD.

Chemist in Charge.

These laboratories were utilized during the year, not only for the chemical work of the Division of Fuels and Fuel Testing, as described below, but also for that of the Division of Ore Dressing and Metallurgy. The staff of chemists employed has been materially increased. In February, Mr. H. C. Mabee—appointed to the Division of Ore Dressing and Metallurgy—took charge of the chemical work of that division. In October, Mr. T. W. Hardy, and in November, Mr. J. H. H. Nicholls, were appointed assistant chemists to the Division of Fuels and Fuel Testing; although Mr. Hardy has spent part of his time assisting Mr. Mabee in the work of the Ore Dressing Division. Dr. Carter has continued throughout the year in the work of fuel testing and the examination of oils and waxes.

The laboratory accommodation has been increased by the addition of a small room which has been fitted up for calorimeter work; and the ventilating system has been improved by the addition of a plenum system, with heating control for the air supply.

The equipment has been increased by the purchase of the following special apparatus, in addition to smaller apparatus and general supplies: Sartorius analytical balance, May-Nelson rotary vacuum pump, Lennox electric blower, Hoskins electric muffle, Hoskins electric hot plate, Leeds and Northrup electric resistance thermometer for calorimetry, Scimatco optical pyrometer, Engler oil distillation apparatus, Thurston oil tester, Parr sulphur bomb, Drehschmidt sulphur in gas apparatus, Burrell mine air analysis apparatus, and a meter tester. Moreover, the following new apparatus, or improvements to old apparatus, have been designed and made on the premises: Kjeldahl nitrogen apparatus, safety attachment to electric water still, automatic gas sampler, Jaeger nitrogen in gas determination apparatus, apparatus for determination of specific gravity of oil, and additions to Randall and Barnhart gas analysis apparatus.

The total number of samples submitted for analysis during the year, exclusive of routine gas samples, was, approximately, the same as in the previous year; but the samples submitted from sources outside the Department of Mines were nearly twice as numerous. The actual work involved in testing the samples submitted was considerably more than the corresponding work of the year before: more special investigations were carried out, and some progress was made with the arrears dating from the time when the present laboratories were being built, so that the total output was far in excess of any previous year. There appears to be no slackening in the steady increase in the demands made upon the laboratories; it is therefore regrettable that they are now working at nearly full capacity, both as regards the number of chemists for whom there is accommodation, and also as regards the varieties of work requiring special apparatus, for which laboratory space can be found.

The samples received include ninety-five coals, thirty-four peats, eleven oils or oil sands, seven ashes, four natural gases, and six miscellaneous samples. Twenty-seven samples were submitted by the Geological Survey; ten by the Board of Railway Commissioners; seventeen by the Department of Militia and Defence; two by the Department of Naval Service, and thirty-two from other parties. Some of the work of the laboratory consisted, as usual, of routine gas analysis in connexion with the large scale boiler and producer trials, carried out on the premises. The determinations made in this connexion include those of the composition and calorific value of gases, together with their ammonia, tar, and water content.

Special work carried out during the year includes: a preliminary investigation on the air drying of coal begun in March—still in progress, daily determinations being made: the design and testing of the new and modified apparatus enumerated above: and the design of a "total heat" attachment for the Boys gas calorimeter: this latter apparatus was not quite completed at the end of the year. The system of recording and reporting the work done in the laboratory has been further improved, and a number of suitable books and forms designed and printed for the purpose. A report on "Products and By-products of Coal" has been prepared by Stansfield and Carter, and will be published shortly. Moreover, at the close of the year arrangements were made for the taking and analysis of mine air samples from the collieries of the Dominion: special apparatus was purchased: record and report forms and books printed: sample tubes obtained and distributed; a special wax for sealing the tubes was prepared; and other preparations made for carrying out this important work in the coming year.

In July, the writer had the privilege of visiting the fuel testing laboratories of the University of Illinois at Urbana, and, through the courtesy of the Director of the Engineering Experiment Station, learned something of the work carried out and the methods employed.

III.

INVESTIGATION OF PEAT BOGS, 1914.

ALEPH VON ANRE̦P.

According to the instructions received from the Chief of the Fuels and Fuel Testing Division, I spent six and one-half months of the field season of 1914 in the investigation of the peat bogs of the provinces of Quebec, Prince Edward Island, and Nova Scotia. The work was continued in order to ascertain the extent, depth, and quality of peat contained in the various bogs.

In connexion with this work, the writer left Ottawa on June 4, Mr. Y. Lamontagne acting as temporary assistant, for a period of a month and one-half. Owing to Mr. Lamontagne's desire to complete his college course, Mr. A. Gentles filled the position throughout the remainder of the season.

As a brief summary of work completed during the season, the following statement is appended:—

QUEBEC PEAT BOGS.

The peat bogs investigated in Quebec during part of June and July, 1914, were:—

(1.) The L'Assomption peat bog, situated 2 miles south of L'Epiphanie station, and about 1½ miles northeast of Cabane Roade station in the Seigneury of L'Assomption.

The total area covered by this bog is approximately 1,565 acres, the depth of the bog varies from 3 to 15 feet.

(2.) St. Isidore peat bog, situated about 3 miles south of St. Isidore station in the Seigneuries of:—

Chateauguay—La Prairie county.
Beauharnois—Chateauguay county.
La Salle—Napierville county.

The total area covered is approximately 1,931 acres, the depth varying from 3 to 11 feet.

(3.) Holton peat bog, situated 2 miles east of Holton station and 1 mile west of Barrington, in the counties of Chateauguay, Napierville, and Huntingdon.

The total area covered is about 6,181 acres, the depth varying from 4 to 6 feet.

The approximate total area investigated in the Province of Quebec during the season of 1914 was 9,677 acres.

PRINCE EDWARD ISLAND PEAT BOGS.

During the investigations in Prince Edward Island, carried on in the latter part of July and in the month of August, 1914, the following bogs were surveyed:—

(4.) The Black Marsh peat bog, situated 6 miles north of Tignish, lot 1, North county.

The total area covered was approximately 650 acres, varying in depth from 3 to 6 feet.

(5.) The Portage peat bog, situated about 1 mile east of Portage station, Halifax township, Prince county.

The total area of this bog is about 775 acres, of which 148 acres are peat litter, with a depth from 4 to 7 feet.

(6.) The Miscouche peat bog, situated about 1 mile from St. Nicholas station in lots 16 and 17, Richmond township, Prince county.

The total area covered by this bog is about 2,900 acres, of which 103 acres are peat litter with an average depth of 13 feet, and 2,797 acres, peat fuel, with a depth varying from 2 to 7 feet.

(7.) The Muddy Creek peat bog, situated about 3 miles southwest of St. Nicholas station, in lot 17, Richmond township, Prince county.

The total area covered was about 61 acres, with an average depth of 3 feet.

(8.) The Mount Stewart peat bog, situated in lot 35, about 1 mile south of Mount Stewart village.

The approximate total area investigated in Prince Edward Island during the season 1914 was 4,386 acres.

NOVA SCOTIA PEAT BOGS.

The peat bogs investigated in Nova Scotia, from the beginning of September to the middle of December, 1914, were:—

(9.) The Cariboo peat bog, situated about 1½ miles west from Berwick station, Kings county, on the line of the Dominion Atlantic railway, and about 2 miles west by the Post road.

The total area covered by this bog is about 887 acres, of which 200 acres with a depth varying from 16 to 26 feet, and 687 acres with a depth varying from 3 to 12 feet, are suitable for the manufacture of peat fuel.

(10.) The Cherryfield peat bog, situated about one-half mile southeast of Cherryfield station, Lunenburg county.

The total area covered by the bog is approximately 160 acres, with a depth varying from 3 to 20 feet.

(11.) The Tusket peat bog, situated to the southeast and east of Tusket station, Yarmouth county.

The total area covered by this bog is approximately 235 acres, the depth varying from 3 to 13 feet.

(12.) The Makoke peat bog, situated about 1½ miles south of Tusket station, Yarmouth county.

The total area covered is about 460 acres having a depth of from 4 to 12 feet.

(13.) The Heath peat bogs, situated in Yarmouth county, 1½ miles east of Argyle Head, about 1 mile east and west of Central Argyle station, and 2 miles east of Lower Argyle.

The total area of this bog is about 2,174 acres.

(14.) The Port Clyde peat bog, situated in Shelburne county, about 3 miles west of Port Clyde station, on the Halifax and Southwestern railway.

The total area covered by this bog is approximately 1,666 acres, the depth varying from 3 to 11 feet.

(15.) The Latour peat bog, situated in Shelburne county, about 1½ miles southwest of Upper Port Latour.

The total area of this bog is about 849 acres, having a depth of from 3 to 11 feet.

(16.) The Clyde peat bog, situated in Shelburne county, about 2½ miles northeast of Clyde River village. Two and one-half miles north of this village, the bog follows the Clyde river.

The total area of this bog is approximately 2,240 acres, with a depth varying from 2 to 21 feet.

The approximate total area investigated in the province of Nova Scotia during the season of 1914, is 8,671 acres, making a total area investigated during the season 1914, of 22,734 acres.

This figure is somewhat less than that of the previous year, but accounted for by the fact that the bogs investigated were spread over three Provinces, and many of them were difficult of access, owing to the wooded nature of the surrounding district.

During the latter part of July, I visited the peat plant at Alfred, completed earlier in the season, and which was in operation the whole day, thus offering an opportunity for inspection.

Detail description, deliminations, profiles and maps of the above mentioned peat beds, etc., will be published in a separate report.

IV.

REPORT ON MECHANICAL WORK DONE AT THE FUEL TESTING STATION, ETC.

To B. F. HAANEL, B.Sc.,
Chief Engineer,
Division of Fuels and Fuel Testing,
Mines Branch, Dept. of Mines.

SIR,—Herewith appended is an abstract of the records that have been kept, showing the amount of work done, and the labour and material expended thereon: arranged under the heading of the department to which the same has been charged, and covering the period from April 1, 1914, to March 31, 1915.

The work shown in this report does not include the cleaning of machinery, attention to belts, pulleys, shafting, bearings, etc., to keep the plant in first-class running order. I may mention that to keep account of the cost of the above work, I am adopting a daily time card, so that the hourly occupation of each man is charged to whatever work he is doing during the day, the total of the same representing the total number of hours he has worked during the day, thus accounting for the occupation of each employee.

All of which is respectfully submitted.

A. W. MANTLE,
Mechanical Supt.

FUEL TESTING STATION.

——	Labour.	Material.
	$ cts.	$ cts.
Main bearing for Korting gas engine—		
Labour, 74 hours at 48c..	35 52	21 00
Making emery wheel stand—		
Labour, 33 hours at 48c..	15 84	4 50
Making and fitting brackets for small motor—		
Labour, 30 hours at 48c..	14 40	1 40
Making parallel strips for machine shop—		
Labour, 15 hours at 48c..	7 20	4 00
Forging and machining slot holes for shaper—		
Labour, 19 hours at 48c..	9 12	1 28
Making face plate for milling machine—		
Labour, 18 hours at 48c..	8 64	2 00
Two angle plates for machine shop—		
Labour, 19 hours at 48c..	9 12	3 60
Machining jaws of vise for shaper—		
Labour, 3 hours at 48c..	1 44	
Making two forge stands for holding bars—		
Labour, 3½ hours at 28c..	98	2 70
Making set of six cutters for keyways—		
Labour, 22½ hours at 48c..	10 80	1 08
Making expanding bushing for grinder—		
Labour, 2 hours at 48c	96	25
Repairing pokers for producer		
Labour, 3 hours at 48c..	1 44	
Repairing antipulsator		
Labour, 6 hours at 28c..	1 68	
Polishing and lacquering electric fixtures—		
Labour, 37½ hours at 28c..	10 50	
Buff sink fittings		
Labour, ¾ hour at 28c..	21	
Making pattern for electrical cutout on still—		
Labour, 2 hours at 28c	56	

FUEL TESTING STATION—*Concluded.*

	Labour.	Material.
	$ cts.	$ cts.
Making two air boxes for Westinghouse producer—		
Labour, 41 hours at 48c	19 68	14 64
Making "T" slot cutter—		
Labour, 11½ hours at 48c	5 52	23
Making special tool holder for shaping machine—		
Labour, 19 hours at 48c	9 12	55
Making pattern for tool holder—		
Labour, 5 hours at 28c	1 40	50
Making tools for milling machine (fly cutters)—		
Labour, 5 hours at 48c	2 40	
Making special relief valve for Westinghouse producer—		
Labour, 10 hours at 48c	4 80	2 85
Changing piping on Westinghouse producer to suit new air boxes—		
Labour, 26 hours at 28c	7 28	5 90
Making measure for producer—		
Labour, 2 hours at 28c	56	10
Repairing portable engine, which includes making new cross head, new slide bars, cylinder head, piston rod, new valves and thorough overhauling. Straightening crank shaft and fitting key (Last item done at Lawson's.)	28 50	
New cross head—		
Labour, 30 hours at 48c	14 40	2 40
New cylinder cover—		
Labour, 21 hours at 48c	10 08	4 80
" 220 hours at 28c	61 60	
Fitting and repairing—		
Labour, 220 hours at 25c	55 00	7 50

CHEMICAL LABORATORY.

	Labour.	Material.
Making brackets and fittings for roller sun blind—		
Labour, 46½ hours at 28c	13 02	
" 19½ hours at 25c	4 88	
" 5 hours at 48c	2 40	4 80
Making automatic electric cutout for water still—		
Labour, 14 hours at 48c	6 72	75
Making and fitting iron drying shelves—		
Labour, 10 hours at 28c	2 80	1 40
Making total heat attachment for Boys calorimeter—		
Labour	12 50	6 85
Making small copper water trap 6 inches by 1 inch—		
Labour, 4 hours at 48c	1 92	30
Making special nitrogen distillation apparatus—		
Labour, (J. Philips, tinsmith)	14 72	4 50
Total	$407 71	$100 38
Add—		
Making mixing chamber for steam and air on Westinghouse producer—		
Labour, 8 hours at 48c	3 84	
" 10 hours at 28c	2 80	14 10
" 10 hours at 25c	2 50	
Total	$416 85	$114 48

ORE DRESSING LABORATORY.

	Labour.	Material.
Making and erecting belt shifter for No. 1 pump—		
Labour, 13 hours at 28c	3 64	
13 hours at 25c	3 25	3 40
Making and erecting belt shifter for No. 2 pump—		
Labour. 12 hours at 28c	3 36	
12 hours at 25c	3 00	3 25
Making and erecting belt shifter for No. 3 pump—		
Labour, 14 hours at 28c	3 92	3 70
14 hours at 25c	3 50	

ORE DRESSING LABORATORY—*Continued.*

——	Labour.	Material.
	$ cts.	$ cts.
Making and erecting belt shifter for No. 4 pump—		
Labour, 12½ hours at 28c	3 50	3 60
12½ hours at 25c	3 13	
Making and erecting belt shifter for Deister table—		
Labour, 15 hours at 28c	4 20	3 80
15 hours at 25c	3 95	
Making and erecting belt shifter for Overstrom table—		
Labour, 14½ hours at 28c	4 06	3 75
14 hours at 25c	3 50	
Making and erecting belt shifter for No. 2 elevator—		
Labour, 12 hours at 28c	3 36	3 55
12 hours at 25c	3 00	
Special belt tighteners on concentrating tables—		
Labour, 40 hours at 48c	19 20	
" in fitting, 19 hours at 28c	4 42	5 75
Making two special steel tanks for Richards jig—		
Labour, 298¼ hours at 28c	83 51	28 70
Repairing and adjusting No. 1 elevator—		
Labour, 10 hours at 28c	2 94	
10½ hours at 25c	2 63	
Adjusting Deister table bearings—		
Labour, 11 hours at 28c	3 08	
Repairing and adjusting friction clutch on crusher—		
Labour, 8 hours at 28c	2 24	2 70
Making and erecting belt shifter for air compressor—		
Labour, 24 hours at 28c	6 72	3 60
Fitting spiral ore conveyers to bins—		
Labour, 64 hours at 28c	17 92	7 50
64 hours at 25c	16 00	
Making spout for Richard laboratory jig No. 1—		
Labour, 1 hour at 28c	0 28	0 10
Making conveyer boxes—		
Labour, 20 hours at 40c	8 00	3 40
Making motor belt tighteners, machining castings and cutting gears—		
Labour, 151 hours at 48c	72 48	
" in fitting, 65 hours at 28c	18 20	4 80
Making special elevating screws for Overstrom table—		
Labour, 16 hours at 28c	4 48	0 64
Erecting air compressors—		
Labour, 24 hours at 28c	6 72	
" 24 hours at 25c	6 00	1 50
Erecting shafting and clutch for air compressors—		
Labour, 28 hours at 28c	7 84	
Making four ball thrust bearings for No. 1 and No. 2 line shafts—		
Labour, 44 hours at 48c	21 12	7 25
Fitting ball thrust bearings in wall and on shaft—		
Labour, 32½ hours at 28c	9 10	0 25
Machining two pairs of grinding plates for Baumé pulverizer—		
Labour, 12 hours at 48c	5 75	4 16
Making bracket pattern for shaft bearings in roaster building—		
Labour, 6 hours at 28c	1 68	0 25
Making brackets for shaft bearings roaster building—		
Labour, 6 hours at 28c	1 68	3 40
Making large anchor bolts for large smokestack for roaster building—		
Labour, 8 hours at 48c	3 84	6 97
"Special"—Making cyanide machine including 12 sheaves, 6 spindles, 12 bearings, shafting and two pulleys—		
Labour, 96 hours at 48c	46 88	
In erecting, 56 hours at 25c	14 40	9 30
Erecting rotary roaster furnace—		
Labour, 125 hours at 28c	35 00	
" 88 hours at 25c	22 00	91 75
" 384 hours at 43¾c	168 00	
Making eight special columns for steel work in roaster building—		
Labour, pattern making, 8 hours at 28c	2 28	50
" machine castings, 24 hours at 48c	11 52	
Cutting pipes for columns—		
Labour, 6 hours at 48c	2 88	51 60

ORE DRESSING LABORATORY—*Concluded.*

	Labour.	Material.
	$ cts.	$ cts.
Erecting steel structure for receiving tank and overhead gear and shafting—		
Labour, 254 hours at 28c	71 12	239 96
" 210 hours at 25c	52 50	
Making and fitting small door in roaster building—		
Labour, 30 hours at 28c	8 40	3 60
Making special roller feeder for pneumatic jig—		
Labour,—pattern-making, 8 hours at 40c	3 20	
" machine work, 86 hours at 48c	41 28	4 50
Total	854 66	507 24

SUSSEX STREET.

	Labour.	Material.
Making ten brass discs ⅛-inch larger in diameter than sample—		
Labour, 5½ hours at 48c	2 64	1 50
Making six brass discs as per sample—		
Labour, 4 hours at 48c	1 92	1 25
Making four brass plates as per sample—		
Labour, 3 hours at 48c	1 44	70
Straightening copper boiler, truing circle of mouth—		
Labour, 3 hours at 48c	1 44	
Fitting dust collecter—		
Labour, 4 hours at 28c	1 12	
Making emery wheel attachment for motor—		
Labour, 6 hours at 48c	2 88	15
Making improved electroscope—		
Labour, pattern-making, 8 hours at 48c	3 84	
" machining, 48 hours at 48c	23 04	10 50
Making cement mixing table—		
Labour, 20 hours at 48c	9 60	35 78
Erecting machinery for Mr. Cole—		
Labour, 24 hours at 48c	11 52	
" 24 hours at 20c	4 80	
Total	64 24	49 88

SUMMARY.

	Labour.	Material.
Fuel Testing Station	348 75	81 78
Miscellaneous Work—		
Repairs to portable engine	198 46	21 10
Chemical laboratory	58 96	18 60
Ore Dressing laboratory	854 66	507 24
Roaster building	255 56	157 82
Sussex Street	64 24	49 88
Total	1,780 63	886 42

DIVISION OF CHEMISTRY.

THE CHEMICAL LABORATORY, SUSSEX STREET.

F. G. WAIT.

Chief of the Division.

The work in the chemical laboratory has, for the most part, been along the same lines as in former years. One new field of research, however, has been opened up, and work in it carried on continuously since June, namely, the investigation of the mineral waters of Canada.

A few explanatory remarks regarding the scope of this new work may, appropriately, be given here.

The investigation is to comprise not only a complete chemical analysis of the several waters, together with a study of their physical properties, but special attention is to be given to their radio-activity.

A well or spring water may contain in solution—in addition to the saline constituents usually present:—

(a) Radium emanation: the gas which is a product of the continual decomposition of radium, or its salts, and which has come to be regarded as a therapeutically important factor; and

(b) the gas *(a)* and extremely small quantities of radium salts.

As radium emanation rapidly decays—one-half the initial quantity dying in four days—its estimation should be made at the time of the collection of the sample, or as soon as possible thereafter.

To satisfactorily make this examination, it is intended that an expert officer of the Department shall personally visit each water source, and make, on the spot, those tests which I have stated should be made at the time of collection; take such observations of the physical character of the water as may be desirable and possible; and, at the same time, collect and send to Ottawa a sufficient quantity of the water for the subsequent chemical analysis.

Work along these lines has been carried on during the summer of 1914 by Dr. John Satterly, Associate Professor of Physics in the University of Toronto, assisted by Mr. R. T. Elworthy, B.Sc. (London), and, by the last named, after Dr. Satterly's return to Toronto, in September.

In order to facilitate the prompt examination of the waters collected, arrangements were made for the determination of the radio-activity at three centres, namely:

1. The laboratory of the Mines Branch at Ottawa.
2. The bottling works of the Caledonia Springs Co., at Caledonia Springs, Ont., and
3. In the laboratories of the Macdonald Physics Building, of McGill University, at Montreal.

At each of these places suitable accommodation was provided for the setting up of electroscopes, and the operation of the necessary accessories, and to each of these the samples collected in their respective neighbourhoods were sent, and the desired determinations made with all possible expedition.

For the determination of the dissolved radium, as well as for the chemical analysis, a sufficient quantity of the water was forwarded to Ottawa.

The following springs or sources have been visited, and their waters examined in the manner outlined:—

(a) Examination made in Ottawa:—

Gillan's spring, near Pakenham.
Sanitaris Water Co.'s spring, at Arnprior.
Borthwick spring, near Hawthorne.
Victoria sulphur spring, near Ottawa.
Russell Lithia Water Co.'s springs (2) at Bourget.
Carlsbad springs—five in number.
Several civic wells, and other private sources, in and about Ottawa.

(b) At Caledonia Springs:—

Five of the best known Caledonia springs.
Two saline waters owned by Charles Gurd & Co., of Montreal, situated at Caledonia Springs.
Adanac water, at Bourget.
Plantagenet mineral water; and
A copious spring at Alfred, Ont.

(c) At Macdonald Physics Building, Montreal:—

Abenakis springs (2) at St. Francis du Lac.
Berthier.
Maskinonge.
Potton.
Radnor Forges.
Richelieu.
Ste. Agathe.
St. Benoit.
Ste. Genevieve.
Ste. Hyacinthe.
St. Leon.
St. Severe.
Varennes.
Viauville: remarkable for the large quantity of hydrogen sulpide it contains.

together with samples from several of the "Artesian and other Deep Wells of the Island of Montreal," referred to in a report published by the Geological Survey of Canada, under the above caption, by Dr. F. D. Adams.

Detailed results of the work done this season will not be published until the chemical analyses are completed; but it can be stated that in most of the instances the waters examined were slightly radio-active, giving values of the same order of magnitude as those from other parts of the world where results have been recorded.

With regard to the other work carried on during the year, the several items are susceptible of classification, and for purpose of ready reference, may be arranged under the following headings:—

ASSAYS.

One hundred and thirty-two samples of gold, silver, and—in a few instances—platinum ores, from the undermentioned Provinces, have been examined:—

i. From Nova Scotia, one sample.
ii. " Quebec, six samples.
iii. " Ontario, thirty-nine samples.
iv. " Manitoba, one sample.
v. " Saskatchewan, twenty-two samples.

vi. From Alberta, two samples.
vii. “ British Columbia, five samples.
viii. “ Yukon Territory, nine samples.
ix. and forty-eight others, concerning which insufficient, or no data as to locality of occurrence, was furnished.

CLAY.

Qualitative examinations of six samples of clay have been made, to ascertain if they were suitable for employment either in brick making, or as an ingredient of artificial Portland cement. The examinations so made were of a very unsatisfactory and indefinite character, hence it is gratifying to be able to allude to the new Division of Ceramics, now in process of establishment in connexion with the Mines Branch, and to which all clay samples may in future be sent for examination and testing.

None of the samples referred to above were of enough interest to merit special notice here.

COPPER ORES.

Twelve samples of copper-bearing ores: one from Nova Scotia; one from New Brunswick; three from Ontario; two from the Yukon; and five from unspecified localities have been examined. In connexion with this collection of copper ores, however, there is much to be desired in the way of more complete information as to locality of occurrence. As the matter stands, our report can only state that the particular specimen examined comes from an undesignated locality; often without even the name of the province being given. It is manifest, therefore, that a report so indefinite is of little value, either to the recipient, because it lacks definiteness, or to the Department, since it conveys no information of the mineral worth of any particular deposit or area.

IRON ORES.

Eighteen samples of iron ores have been submitted, either for complete, or for partial analysis, from the following localities:—

(a) Cape Breton county, N.S. Four samples from—
   i. The Curry property.
   ii. W. Mackenzie farm at Marion Bridge.
   iii. “ Pit No. 2.
   iv. Grand Mira, South.
(b) Richmond county, N.S. Two samples from—
   i. D. McIntyre's property, Loch Lomond.
   ii. Robinson property, at Barra Head.
(c) Antigonish county, N.S. One sample from—
   Arisaig iron district;

while eleven other samples must be put down as from ‘undefined localities.’

LEAD ORES.

The smelter returns from the output of several of the auriferous quartz workings in the Yukon, having been found to be slightly above that indicated by the test assays, it was deemed advisable to determine the lead content of such as were thought might be plumbiferous. To that end, some 378 samples were analysed. Of that number,

20 contained only traces of lead.
60 “ less than one per cent of lead.
11 “ more than one, but less than two per cent.
17 “ “ two, “ three per cent.
10 “ “ three, “ four per cent.
12 “ “ four, “ five per cent.
5 “ “ five per cent, while
219 contained no lead whatever.

LIMESTONES.

During the year, fifty-two samples of limestones and dolomites have been analysed by Mr. Leverin.

Nineteen samples were from the following named quarries in the vicinity of St. John, N.B.:—

i. Charles Miller's, two samples; one of blue, and one of yellow limestone.
ii. Stetson and Cutter's, four samples; three of blue limestone, and one of white dolomite.
iii. Purdy and Green's, two samples of blue limestone.
iv. Randolph and Baker's, seven samples; three of blue, two of white, and one of yellow limestone, and one of white dolomite.
v. From Drury Cove, three samples of blue limestone.
vi. From Green Head, one sample of altered limestone.

The remaining thirty-two samples were collected by Mr. Fréchette, from the undermentioned localities in western Quebec:—

Pontiac county, lot 26, range I, of Clarendon.
" an island at Portage du Fort.
" quarry at Portage du Fort.
" Carswell's quarry, at Bryson (2 samples).
" lot 4, range VIII, of Clarendon.
" lot 8, range I, of Clarendon.
" on C. N. R. property, at Bristol.
" lot 12, range III, of Onslow.

Wright county, quarries at Hull; at Ste. Cecile de Masham; at Farrellton; and at Paugan Falls.

Ottawa county, lot 39, range VIII, of Aylwin.
" lot 16, range III, of Aylwin.
" lots 6 and 7, range VI, of Aylwin.

Labelle county, from bed of Lievre river at Masson.

Argenteuil county, lot 21, range I, of Harrington.
" " 10, " VIII, of Grenville.
" " 15, " IX, of Grenville.
" " 7, " IV, of Grenville.
" " 15, " III, of Grenville.
" quarry near Calumet.
" lot 17, range IV (Lanes Purchase), north of Lachute.
" quarry one-half mile south of Lachute.
" quarry at Carillon.
" from Ottawa river between Cushing and Stonefield.

(And one sample from the Ontario end of the dam at Carillon.)

Terrebonne county, from P. Sanche's quarry, 3 miles N.E. of Ste. Therese.
" from a quarry at Ste. Therese.
" from a quarry one-half mile south of Ste. Therese.
" from a point 2 miles west of Piedmont.

Laval county, from N. Brunel's quarry, near St. Vincent de Paul.

Mr. Fréchette's collection comprised some 110 samples: but the analyses of the above 32 only had been completed within the time covered by this summary.

MOLYBDENITE.

Three samples of this mineral have been examined. One was from lots 7 and 8 of range II of Eardley township, Pontiac county; and two from the west half of lot 28, concession IV, of Bagot, Renfrew county, Ontario.

NICKEL AND COBALT ORES.

Eight samples—one each from—

(i) A point 1 mile from tide water, on the east side of King street, St. Stephen, N.B.
(ii) Calumet island, Pontiac county, Que.
(iii) Sesekinika lake, Ont., and
(iv) Lot 20, concessions III and IV of Bagot township, Renfrew county, Ont., and

Four from unspecified localities.

ROCK AND MINERAL ANALYSES.

With the continued augmentation of the staff of both the Geological Survey and Mines Branches of the Department of Mines, there has been a gradual increase in the number of specimens of rocks and minerals sent for exhaustive chemical analysis.

Mr. M. F. Connor and Mr. N. L. Turner have both been carrying on this class of work, Mr. Connor's whole time being devoted to it, while Mr. Turner has been called upon to do other work from time to time.

Even with the service of two chemists available, it is not possible to issue reports as soon as the collectors of the samples desire.

It has accordingly happened on more than one occasion that summary, or other, reports have either been delayed, or have been issued in an incomplete condition.

It would appear that additional assistance in this class of work will soon be demanded.

During 1914, analyses of the following have been completed and reported, and work upon others commenced:—

Six feldspars from Ottawa county, Quebec, as follows:—

(i) O'Brien mine, lot 21, range VI, of West Portland township.
(ii) Villeneuve mine (microcline), lot 21, range I, of Villeneuve.
(iii) Villeneuve mine, (albite, peristerite), lot 21, range I, of Villeneuve.
(iv) Leduc mine (amazonite), east half of lot 25, range VIII, of Wakefield township.
(v) Leduc mine, second sample.
(vi) Pearson mine, lot 13, range XII, of Buckingham township.

Three feldspars from Saguenay county, Quebec.

(vii) Canadian Feldspar Company's mine at Manicouagan bay.
(viii) Lac Pied du Monts mines, at Lac Pied du Monts (two samples).

Two feldspars from Frontenac county, Ontario.

(ix) Gamey mine, on lot 5, concession XIII, of Portland township.
(x) Richardson mine, lot 1, concession II, of Bedford township.

One feldspar from Lanark county, Ontario, from—

(xi) Silver Queen, or Smith mine, situated on east half of lot 13, concession V, of North Burgess.

The foregoing twelve samples were all collected by Mr. H. S. de Schmid, of the Mines Branch staff.

(xii) Residual red clay, collected by Mr. R. G. McConnell, on Texada island, B.C.

(xiii) Muscovite granite, from one-fourth mile southwest of Larder river, and one-fourth mile below its junction with Ross Meadow brook, N.S.

(xiv) Biotite granite, from a point a mile and a half north of Wallaback lake, N.S.

The two immediately foregoing were collected by Mr. W. J. Wright, of the Geological Survey.

(xv) Quartz diorite.
(xvi) Granodiorite.
(xvii) Pulaskite.
(xviii) Dike.

One sample of each of the foregoing was collected in the Beaverdell district of British Columbia by Mr. L. Reinecke, of the Geological Survey.

(xix) Analcite rock, and
(xx) Analcite crystals.

Collected by Mr. J. D. Mackenzie, of the Geological Survey staff, on section 3, township 6, range 4, west of 5th meridian.

(xxi) Silt, from Thompson river, near Ducks, B.C.

Collected by Dr. R. A. Daly.

(xxii) Six rocks, collected by Mr. O. E. Leroy, of the Geological Survey Branch, at Franklin, B.C., as follows:—

Monzonite.
Minette.
Syenite.
Felspathic pyroxenite.
Basalt.
Trachyte.

(xxiii) Six specimens from Kyoquot sound, Vancouver island, collected by Mr. C. H. Clapp.

(xxiv) Three rocks from the Mount Royal tunnel in the city of Montreal, collected by Professor J. A. Bancroft, of McGill University, were fully analysed, and a partial analysis and a preliminary report made upon six others from the same locality.

(xxv) A slightly pyritiferous argillite from an undefined locality in New Brunswick—sample submitted by Honourable James Domville.

WATERS.

In addition to the work done in water investigation, as already referred to, five waters have been qualitatively examined.

Two were from Ontario; one sample being taken from a boring 175 feet deep, near Pendleton, and another from a spring on lot (?), concession I, of Alfred, both in Prescott county.

One sample was sent by Mr. W. B. Nicholson, of Gilbert Plains, Manitoba.

A sample sent from Hayter, Alberta, was thought by the sender to be indicative of oil, but examination proved that this was not the case.

The fifth sample examined was collected at Refuge cove, on the west coast of Vancouver island, by Mr. Charles Clapp, of the Geological Survey staff.

ZINC ORES.

Determinations of zinc were made in two samples submitted.

One was collected by Mr. E. Lindeman, of the Mines Branch staff, at East Bay mine, in Cape Breton county, N.S.; the other was submitted by Mr. G. C. Mackenzie as an umpire sample of certain of the zinc ores abounding at or near Nelson, B.C.

MISCELLANEOUS MATERIALS.

Under this heading is grouped a wide variety of materials, some of which are of more than passing interest, but on account of the meagre information furnished cannot be made use of.

Sand, bricks, clay (supposed pigment), mica, shale, marl, silt, graphitic rock, meteorite, are some of the materials included here. Twenty-four such samples were examined.

Some 882 specimens of various kinds have thus been accounted for, and the work upon them completed and reported.

In carrying out the necessary practical work, the three assistants, Mr. M. F. Connor, B.Sc., Mr. H. A. Leverin, Ch.E., and Mr. N. L. Turner, M.A., have given close attention to the duties assigned them, and their work has been highly commendable.

REPORT OF THE DIVISION OF MINERAL RESOURCES AND STATISTICS.

John McLeish.

Chief of Division.

A preliminary report on the Mineral Production of Canada, during the calendar year 1914, has already been completed, and separately published, and will be included as an appendix to this report.

The work of this division, which has been described in previous Summary Reports, consists chiefly in the annual collection of statistics of mining and metallurgical production, and the compilation and publication of reports thereon.

The period covered by the statistical record is the calendar year, the twelve months ending December 31. Thus, in January, 1914, schedules were distributed to mining companies throughout Canada, requesting returns of production during the calendar year 1913. In many cases the mine operators have not the information available until several weeks, or even months, after the close of the year. However, sufficient information was available to complete a preliminary report, which was sent to press during the last week in February, and was distributed during the following week. The preparation of the complete and final reports was then undertaken. A revised edition of the report on Economic Minerals and Mining Industries of Canada was prepared for distribution at the Panama Pacific Exposition. The usual lists of mine and quarry operators were compiled, including, for the first time, a list of non-metal mine operators, and a list of sand and gravel operators.

It is with the deepest regret that we have to record the loss, by death, of Mr. Cosmo T. Cartwright, Assistant Mining Engineer in this Division. Mr. Cartwright died in Kingston, October 27, after having been in failing health from about the middle of August. For several years, Mr. Cartwright has prepared the special chapters in the annual statistical report on the production of Gold, Silver, Copper, Lead, Nickel, and Zinc, and had just completed his report covering the year 1913. Being a man of the highest integrity and personal honour, his passing is deeply deplored by his associates, and as he was particularly well informed concerning the mining industry in western Canada his loss has been a severe one to the Division. No matter how capable his successor, it will require considerable experience to render equivalent service.

The writer, together with Mr. Cartwright, attended the annual convention of the Canadian Mining Institute in Montreal, March 4 to 6, in the interests of the Division, and, as usual, a short paper was presented on the Mineral Production of Canada during 1913. A visit was paid to Sydney, N.S., April 14 to 17, and an illustrated paper on certain phases of the mining industry was presented to the Mining Society of Nova Scotia. Through the courtesy of the Dominion Steel Corporation, the iron and steel plant at Sydney, and several of the collieries in the district were visited, subsequently, several days were spent at New Glasgow, Halifax, and Truro.

On September 25, I received notification of my appointment as member of a special committee to investigate certain points in connexion with the iron mining industry in Canada, and from that date to the close of the year a good deal of my own time was taken up with the work of that committee.

The publication as advance chapters of separate parts of the final report on mineral production was again continued; and in pursuance of this plan, five separate chapters were completed on the dates shown in the following list.

REPORTS AND LISTS OF MINE OPERATORS COMPLETED FOR PUBLICATION DURING THE YEAR.

Reports:—

Preliminary Report on the Mineral Production of Canada during the calendar year 1913—February 24.
The Production of Iron and Steel in Canada during the calendar year 1913 —July 14.
The Production of Coal and Coke in Canada during the calendar year 1913 —July 27.
The Production of Copper, Gold, Lead, Nickel, Silver, Zinc and other metals in Canada during the calendar year 1913—July 30.
The Production of Cement, Lime, Clay Products, Stone and other structural materials in Canada during the calendar year 1913—August 24.
A General Summary of the Mineral Production of Canada during the calendar year 1913—September 4.
Annual Report on the Mineral Production of Canada during the calendar year 1913—September 9.
Economic Minerals and Mining Industries of Canada, Panama Pacific Edition 1914—October 19.

Lists of Mine and Quarry Operators:—

List of Coal Mine Operators in Canada—June 6.
List of Mines in Canada (other than metal mines, coal mines, stone quarries, clay plants, etc.)—July 21.
List of Manufacturers of Clay Products, of Sand-Lime Brick and of Cement in Canada—September 22.
List of Stone Quarry Operators in Canada—October 5.
List of Lime Kilns in Canada—October 6.
List of Operators of Sand and Gravel pits or deposits—October 14.

The correspondence of the division during the year comprised about 9,870 letters and circulars sent out, and 3,868 received. The amount of work involved in the compilation of statistics of production, imports and exports; the preparation and revision of lists of operators; the writing and checking of reports; indexing of mining literature, and of the incorporation of mining companies, together with other routine work of the division, has increased very greatly during the past few years. During 1914, the assistance of one temporary clerk was secured, namely, from November 20 to the end of the year.

Much time is taken up in the preparation of information for correspondents and others respecting the mining industries and mineral resources of the country: an endeavour being made in all cases, so far as the records and reports of the Department will permit, to furnish enquirers with the information required, or to advise them where it may be obtained.

During 1914, and particularly after the outbreak of the war, a considerable number of inquiries have been received relative to the mineral resources of Canada, and more especially with regard to possible supplies of barytes, celestite or strontium sulphate, chromite, infusorial earth, magnesite, molybdenite, etc.

The war had an immediate effect in the dislocation of commerce; the closing of market exchanges involving the temporary cessation of metal and mineral quotations, all of which seriously restricted the output, and accentuated the decrease in production, which was already expected, as a result of the financial stringency of 1913, and the culmination of land and other speculation.

So soon, however, as control of the sea was demonstrated, market quotations and trading were resumed at reduced prices.

The continuance of the war increased the demand for many metals such as copper, lead, zinc, antimony, molybdenum, etc., the prices of which rapidly rose to levels equal to, or higher than, those previously prevailing.

In view of the dependence of the Empire upon German and European sources for such products as potash salts, coal tar dyes, and other coal tar by-products, cyanide salts, magnesite, kieselguhr, and other mineral products, both natural and manufactured, the war has demonstrated the desirability of the development, as far as possible within the Empire, of those various mineral and metal resources, not only the ores, but also the refined products, now so essential to the nation's life.

The war's demands for iron and steel products has given considerable stimulus to Canadian iron and steel plants at a time when the demands of the general commercial market were approaching a minimum. It is reported that arrangements have already been made for the recovery of toluol and benzol at the coke oven by-product plant at Sydney, and there is every evidence that the mining and metallurgical industries are being stimulated in many directions.

HILLCREST MINE DISASTER.

J. G. S. Hudson.

On the morning of June 19, 1914, a violent explosion occurred in the underground workings of the Hillcrest Colliery, Alberta, causing the death of 189 men; the worst disaster in the history of coal mining in Canada. When the press notices of the explosion, and the appalling loss of life appeared, the Deputy Minister of Mines instructed me to proceed to Hillcrest without delay, and to render any assistance in my power to the Inspector of Mines for that Province; to the management of the Coal Company; and to the representatives of the workmen employed. My written instructions were as follows:—

Office of the Deputy Minister,
Ottawa, June 20, 1914.

J. G. S. Hudson, Esq.,
Mines Branch, Department of Mines,
Ottawa.

Dear Sir,—You are instructed to proceed at once to Hillcrest, Alberta, to investigate the recent appalling disaster at the Hillcrest collieries. You will obtain as full an account of the disaster as possible, with all obtainable facts bearing upon its cause, severity, and consequences. For this purpose you will be present at the inquest. If there is any assistance which you can render the Provincial or other authorities in meeting the overwhelming situation created by this catastrophe, you will place your services at their disposal.

Yours truly,
R. W. Brock.

On receipt of these instructions I left Ottawa on Saturday night, June 20, and arrived at Hillcrest, Alberta, on Wednesday morning, June 24, 1914, and at once proceeded to the Hillcrest mine, where I met Mr. John T. Stirling, Chief Inspector of Mines, Province of Alberta; his Deputy Inspectors of Mines; Mr. I. C. Roberts, Mining Engineer of the United States Bureau of Mines, Denver, Colorado; the General Manager of the colliery, Mr. John Brown; and other officials, and with them proceeded to make an inspection of the underground workings of the mine. After repeated visits, I cannot add any new evidence of importance to that submitted in my first report, which is as follows:—

Frank, Alberta, July 13, 1914.

R. W. Brock, Esq.,
Deputy Minister of Mines,
Department of Mines, Ottawa.

Sir,—We have travelled and examined all that part of the mine wherever the men met their death, either from the violence of the explosion or from poisoning by gas formed after the explosion occurred.

Many parts of the mine show very heavy disruptive force. This is especially noticeable where the levels or other working places required timbering; where the roof of the mine was loose; in haulage landings where mine cars were assembled; and the almost total demolition of the stoppings placed in the mine to conduct the ventilating currents to the working faces.

The Hillcrest mine has a remarkably good natural roof, having only a small portion of what is locally known as cap-rock, that is, a rock between the coal and the characteristic rock forming the roof. It is extremely doubtful if the good roof had not been so strong, whether the larger part of the mine would have ever been regained. It would have been extremely difficult to recover the bodies of the men within so short a time, for on the Saturday following the explosion (which occurred 9.30 A.M. Friday) the greater number of the men who perished were taken out of the mine. As you would anticipate from the fact that in the Hillcrest disaster more men lost their lives than in any previous mine explosion in Canada, a great many mining men were attracted to the scene of the explosion, to ascertain the cause thereof, as the Hillcrest mine was considered one of the best mines in the Crowsnest Pass district.

The usual reports as to the condition of the mine were in order, and on the morning of the explosion there was not an unusual amount of inflammable gas in the mine reported, when the geological formation and heavy angle of inclination at which the seams lie—as in the case of all the mines in the district—are taken into account. In most cases the workings have been started from a level in the mountain side, but at a later date have gone down to the deep, and are under a heavy pressure from the superincumbent strata. These conditions are conducive to exudation of gas, and possible accumulation of coal dust; both conditions of which are now recognized as sources of danger and liability to sudden explosions.

In our inspection of the underground workings, any indications which were found were very contradictory as showing the exact locality where the initial point of ignition took place. This applies also to the disruptive force—demonstrated by the evidence—on mine timber, mine cars, and ventilating stoppings which were in many cases demolished. In one instance an air receiver 3 feet 6 inches in diameter × 9 feet 0 inches long, was carried a distance of 220 feet along the level. The force of the explosion was of great violence at the mine openings, and ventilating fan exits.

At the mouth of one of the slopes the haulage engine house built of concrete 8 inches thick, was blown in; mine cars on the surface were broken, and flung about, and large volumes of smoke and dust were ejected.

On being notified of the disaster, the mine rescue car of the Alberta Department of Mines, stationed at Blairmore, was hurried to the scene of the explosion, with oxygen breathing apparatus, and other appliances, which were of great service, and demonstrated, without any question of a doubt, that the expenditure of money in this equipment was perfectly justifiable.

As in most coal mining accidents, the number of volunteers who offered their services for the recovery of the bodies was without limit; and they rendered assistance which cannot, in many cases, be even acknowledged, since their names were not even known. Many cases of individual bravery can be recorded. In one case, a man re-entered the mine after getting out safely, to try and rescue his two sons, but was unsuccessful, and perished. Another fire boss got out safely from his section of the mine, and went back in the first rescue party, though he had lost two brothers and three cousins. Very many cases such as these might be cited, and goes to show that in cases of emergency, good men always come forward for the rescue parties.

After the explosion, one part of the mine was on fire, but by well directed energy and hard work the individual fires were got under control, thus saving much anxiety, and allowing the rescue parties to proceed with their search work and recovery of the bodies.

As soon as possible after identification and burial of the bodies, relief committees were formed to look after the women and children left dependent.

The official record of the men who lost their lives, due to the explosion, is as follows:—

Number of men who entered the mine on the morning of June 19, 1914	237
Number of men rescued	48
Bodies identified	181
Bodies unidentified	6
Bodies still in the mine (July 13, 1914)	2
Total number of men killed	189

It has been a very difficult matter to determine the actual number of widows and children dependent on the mine workers who lost their lives in the explosion, since quite a large number were from European countries. And it will take some time before the Consuls representing the respective countries can communicate with the proper authorities; but so far it is certain that there are 89 widows and 106 children. Much appreciation was expressed that the Dominion Government acted so promptly, and with such liberality in voting the sum of $50,000 for the relief of the widows and children. The Government of Alberta have also appropriated $20,000 for the same object, and substantial sums were contributed by corporations and private individuals.

Under the statute laws of the Province of Alberta, the Workman's Compensation Act provides that the Hillcrest Coal Company are liable for compensation to the relatives of the men who lost their lives.

I am of opinion that very few mining men would reach a unanimous decision as to the direct cause of the explosion. No direct evidence can be produced as to what actually did take place. All the men who could have given comprehensive statements of facts are dead, so that the findings of the inquiry has, necessarily, to be based on theoretical assumptions, and not on actual facts.

The following is a copy of the official report of the Investigation Commission:—

"REPORT OF THE COMMISSION APPOINTED FOR THE INVESTIGATION AND ENQUIRY INTO THE CAUSE AND EFFECT OF THE HILLCREST MINE DISASTER.

"Calgary, October 20, 1914.

"The Honourable Charles Stewart,
Minister of Public Works,
Edmonton, Alberta.

"Sir,—I have the honour to submit herewith, my report based upon the evidence taken at the enquiry into the Hillcrest Mine disaster, in pursuance of the power vested in me by the Commission bearing date the 24th day of June A.D. 1914. I would ask you to be good enough to place the report before the Lieutenant Governor in Council.

"The hearing of the evidence was begun by me on the 2nd day of July of this year and continued until the 11th day of that month inclusive. The very fullest opportunity was given to the public as well as to all parties interested, to give under oath any evidence or information they desired to give, and throughout the enquiry it was constantly intimated by me that no one who desired to give evidence would be denied that opportunity, and further that if any one could give the names of any parties whose evidence, in their opinion, would be of any assistance to the Commission, upon the handing in of the names of such parties to the counsel appearing for the Government, they would be at once summoned before the Commission and required to give evidence.

"All the evidence available was taken and what might be said to be a fairly thorough inspection of that part of the mine where the explosion was supposed to have occurred, was made by the Commission.

"The report has been delayed owing to not having received the result of the tests of coal dust that were to be made by the United States Bureau of Mines, which tests it was agreed by counsel should be taken into consideration in making this report.

"In addition to Mr. W. M. Campbell, K.C., who appeared on behalf of the Government of the Province, Mr. Colin Macleod acted for the owners of the mine, Mr. J. R. Palmer for the Miners' Union, and Mr. A. J. Kappalle, of Vancouver, for the Royal Italian consul, representing the Italian subjects who were among the victims of the disaster.

"I am forwarding under separate cover the evidence taken at the enquiry, together with the various exhibits put in in evidence.

"I have the honour to be, Sir,

"Your obedient servant,

"A. A. CARPENTER,
"*Commissioner.*

"The explosion in the mine of the Hillcrest Collieries, Limited, occurred, according to the evidence taken at the inquiry, at about 9.30 o'clock in the morning of the 19th of June this year. At the time of the explosion there were 235 employees of the company in the mine. Of these, 189 perished, the only ones saved being those in the northerly portion of the mine, in the workings of what is referred to as Number 1 North Level, where the effect of the explosion was but slightly felt.

"The scope of this inquiry was by the terms of the Commission, to determine as far as possible the cause and effect of this disaster. To follow out the objects of the enquiry, the possible causes of an explosion in a mine of this kind have first to be considered. It is then necessary to arrive as far as possible at the actual condition of the mine immediately prior to the explosion both in regard to the ventilation of the mine, the presence of gas, the condition of the mine in regard to dust, and the character of that dust as regards explosiveness, and any other conditions that might give rise to or contribute to the cause of the explosion. It is also necessary to consider what care the officials of the mine had exercised prior to the explosion, both in the supervision of their employees and generally in the operation and working of the mine. Finally the nature and seat of the explosion, if possible, must be determined.

"In general it may be said that with the exception of what is known as a blown-out shot, all mine explosions must originate with the ignition of gas. In the case of a blown-out shot, however, dust may be ignited directly, and given dust in sufficient quantities and of a sufficiently explosive character, an explosion may result, and a blown-out shot, may of course, result in ignition of the gas. Apart from this, the ignition of gas may be caused in a number of ways. An open flame such as from a match or a naked lamp, a defective safety lamp, the spark from a pick or tool, or the sparking of electric wires or motors may be said to be the most common causes of the ignition of gas in a mine. A fall of rock of such a character as will give off a spark upon falling, and which draws down with it a pocket of gas may also cause this ignition. The mere ignition of gas however, does not necessarily lead to a mine explosion. A great deal will depend on the explosive character of the firedamp, and the condition of the mine air and workings in respect of gas, dust and moisture.

"As regards the possibility of the Hillcrest explosion being originated by a blown-out shot, it is agreed by all the witnesses, that that cause may be eliminated in the present enquiry. All shots in the mine are fired by the examiner by means of an electric battery and cable, and the examiner who alone would have fired the shots in that portion of the mine where the explosion did occur was found with the firing cable wound around his body and the battery key in his pocket. The other examiner on duty in the mine was among those in the workings of Number 1 North Level, all of whom were saved.

"In this mine no naked lights are allowed, the lamp in use being the Wolf Safety Lamp, and these lamps are examined by the examiner before being given out to the men, and were on the morning of the explosion examined by the two examiners on duty at that time. At the same time a safety lamp may become defective through improper handling, as for instance if it is not held erect and comes in contact with the flame, the glass may break, or it may be broken by means of a pick or some tool or by a fall or rock. The probabilities are against a defective safety lamp being the origin of this explosion, but that possibility cannot be elminated.

"The lighting of a match is a cause which also cannot be eliminated. It is a contravention of The Mines Act for men to take matches, pipes or tobacco into a mine of this character, and the management of the mine have the right to search the men for such articles before they go down into the mine, but whether such a search was made or not in this case there is no evidence. Both in this case and in the case of a defective safety lamp the personal equation must largely come in, and it must be remembered that a case of carelessness or foolhardiness on the part of any one employed in such a mine may result in an appalling disaster.

"With regard to a fall of rock such as has been mentioned, obviously no conclusion can be arrived at. The rock formation in this mine is the same as at Bellevue, where some four years ago, a number of explosions, the origin of which was attributed to the sparking emitted upon such a fall, occurred. Evidence was given by two witnesses, (pages 57, 58 and 199 in the evidence) that they had seen a fall of rock cause sparks, some four years ago, in the old working of this mine.

"There is also evidence given as to the striking of sparks by a pick. Given a proper mixture of gas and air an ignition might follow from such a cause.

"As to the sparking of electric wires or motors, there were three electric pumps in Number 2 slope, placed respectively one hundred and thirty feet, nine hundred feet and fifteen hundred feet down the slope and the cables for driving these pumps ran down this slope. The report of the electrician shows that the wires were properly insulated and whatever the effect might be from the danger of these cables and pumps, with the system of ventilation that apparently prevailed in this instance, there is no suggestion that the explosion originated in Number 2 slope and that cause of ignition may, I think, be eliminated.

"The question of the ventilation of the mine is manifestly one of great importance to be considered in connection with this investigation. There is always a certain amount of gas being generated from the coal in a mine of this description, particularly from the working faces, and it is through the proper ventilation of the mine and the proper direction of the air currents, that this gas is carried off, freeing those working places from the undue presence of gas which otherwise would constitute a constant menace to the safety of the mine.

"The exact details of the ventilation system of this mine were known only to the Mine Manager, Mr. Quigley, and the Overman, Mr. Taylor, and both of these officials were among the victims of the disaster. Under the provisions of the Alberta Mines Act the mine operators are not required to keep in their office a plan of the ventilation system of the mine, our Act therein differing from the Coal Mines Act of Great Britain, which makes it obligatory upon the company to keep such a plan in its office. Consequently there was no plan kept of this ventilation system, and as a consequence of the death of these officials, the only evidence that was available in this regard was that of the surviving examiners. At the enquiry a plan of the mine was produced and upon it the examiners traced as nearly as they could the direction of the air currents in their respective districts. While the production of a plan of the ventilation system, as is required to be kept under the provisions of the British Act, would have beyond doubt been more satisfactory, I think on the whole, the evidence of the examiners presents a fairly accurate idea of the ventilation system of this mine.

"By way of explanation, it may be said that there are two entrances to the Hillcrest mine, one called the Rock tunnel, leading to Number 1 slant or slope, and to the new slant, and the other, which is designated as Number 2 slope or slant. All the coal from the workings above or rather east and south of Number 1 slant, is taken up through the Rock tunnel and this part of the mine for the sake of convenience is referred to as Number 1 Mine, while the coal from all the other portions of the mine is taken up the Number 2 slant or slope, and these portions of the mine are, for the same reason, referred to as Number 2 Mine. In reality, however, all the workings are connected and comprise but one mine.

"There were two fans employed in the ventilation of the mine. One, an electrically driven fan of the Sheldon-Sirocco type, placed a little to the south of the Rock Tunnel, acted as an exhaust fan, while the other, a steam driven fan, located a little to the north of the entrance to Number 2 slope, was used as a forcing fan. This latter fan, at the time of the accident, was forcing the air into the workings of that part of the mine known as Number 1 North Level. The return air from Number 1 North Level, apparently joined the intake air going down Number 2 slope. These combined currents travelled down this slope to Number 2 South Level, along the level to the face, returning back along the working faces of Number 2 South, to Room 31, and thence to the exhaust fan through an overcast over the new slant, after ventilating the working places of Number 1 South Level. Another current passed down Number 1 slant, returning along the counter, after having ventilated the places in the level off this slant, and the places above the slant where the pillars were being extracted. The current going through the Rock Tunnel to some extent split at the junction of this tunnel with Number 1 slant and the new slant, a portion travelling down the new slant as far as a stopping at about the second cross-cut in Room 31. That this current, however, did not play any important part in the ventilation of the mine may be judged by the fact that no measurement apparently was ever taken of the air passing down the new slant. The evidence was that a certain amount of this current leaked through this stopping into Room 31, and from these joined the air current ventilating the workings of Number 1 South Level.

"The workings below Number 2 slope as far down as Number 3 South Level according to the plan marked by the Examiners appear to have been ventilated, at least to some extent, by a split of the air current down Number 2 slope, but below Number 3 South Level, the workings were ventilated by means of compressed air and it was almost universally agreed, I think, that the use of compressed air for ventilation purposes in a mine of this character, was objectionable.

"The turning of the return air current from Number 1 North Level, in with the intake current travelling down Number 2 slope and used to ventilate the balance of the workings of Number 2 mine, was severely criticized by Mr. Fraser, the expert witness for the miners and by others, owing to the fact that this would mean that air already vitiated through the ventilation of one portion of the mine, would be turned in to mix with the fresh current of air used to ventilate another part of the mine. It is true that there was an overcast crossing Number 2 slope, a little above the junction of this slope and Number 1 South Level, and had the return air from Number 1 North Level, been carried through this overcast to the surface no objection in regard to this part of the ventilation system could have been raised, and it was at least suggested by counsel for the Company, that this overcast was probably in use at the time of the explosion. The evidence however, I think, is clear, that this overcast was not being used at that time, and it seems to have been a fact that this return current from Number 1 North Level, did travel down Number 2 slope and from there along with the intake current down the slope through the other portion of the workings of Number 2 mine.

"Measurements of the quantity of air taken into the mine at the different intakes are made once a week by the Overman, and the last of these measurements before the disaster, was taken on the 16th of June. On that day, these measurements show that 14,500 cubic feet of air per minute were being forced into the workings of Number 1 North Level, 24,000 cubic feet were being taken in down the Number 2 slope and 54,600 cubic feet were being drawn down Number 1 slant. The conclusion Mr. Fraser arrived at, seems to be that in taking the volume of air coming down Number 2 slope at 24,000 cubic feet, the Overman had included the return air from Number 1 North Level. I cannot come to this conclusion myself. To do so would I think be to impute a species of fraud to this official and a manifest attempt on his part to give a false idea of ventilation of the mine. I do not think there is anything to warrant the adoption of such a view. It is apparent from the measurements that there was a sufficient quantity of air passing through the mine, to insure proper . . . ventilation, provided the air was properly distributed.

"By The Mines Act it is provided that every mine shall be divided into districts or splits of not more than seventy men in each district and each district shall be supplied with a separate current of fresh air. There was a very considerable difference of opinion as to the definition of the word "split." Mr. Fraser adopted the view that the term as used, has the same meaning as the term "ventilation district" used in the British Coal Mines Act, and, as to Number 2 mine, it was suggested by him that Number 1 North Level, and Number 2 South Level, were both on the same split. On the other hand Mr. Drinnan, the company's expert, was inclined to give a much wider, or at least a more vague, interpretation of the term, and, in his opinion, Number 1 North Level, and Number 2 South Level, comprised two distinct splits. Mr. Brown, the company's manager, was of much the same opinion, and I might say here that if the return current from Number 1 North Level, travelled through the overcast, over Number 2 slope, there would be no possible doubt but that there were two distinct districts or splits in Number 2 mine. I am distinctly under the impression, however, that at least the intention of the Alberta Act was that the term "district" or "split" should receive the same meaning as the term "ventilation district" in the British Coal Mines Act.

"Assuming for the moment that there were two distinct splits in Number 2 mine, it still seems that there were considerably more men employed in these workings than the Act sanctions. It is to be regretted that the reports kept by the company do not give very definite information as to the number of men employed in the various parts of the mine. The explanation given was that the men, with the exception of the miners, are often moved from one part of the mine to another. This is quite conceivable, and is indeed undoubtedly the case, but without more definite track being kept of the whereabouts of the men than was apparently done here, it is difficult to see how the section of The Mines Act limiting the number of men in each district or split, can be observed.

"The estimate of Mr. Fraser, as to the number of men employed in Number 2 mine, exclusive of Number 1 North Level, in view of the evidence, is, I think, excessive. It is impossible to fix exactly the number of men employed in Number 2 mine at the time of the disaster. The rescue parties, as may be readily conceived, paid little attention to the location where the bodies of the victims were found, and even the location of the bodies would not be conclusive in this regard, as there is little doubt but that many of the men, after the explosion, left their working places, in an attempt to escape, before they succumbed to the effect of the afterdamp.

"According to the figures submitted by the company as showing the number of men checked into the mine on the morning of the disaster, there were fifty-nine men in Number 1 mine and one hundred and seventy-six in Number 2 mine. All of the men in Number 1 North Level, forty six in number, were saved, so that in the remaining portion of Number 2 mine the company's figures would show that there were one hundred and thirty men. The evidence bears out, however, the company's explanation that the men were moved about the mine after being sent into it, as while the figures show that there were three tracklayers in Number 2 mine, and none in Number 1 mine, the evidence is that one of these men was killed in Number 1 mine Again, while there is no strict evidence on the point, it appears that the number of buckers found in Number 1 mine was very considerably greater than the company's figures show. I think that possibly an extreme estimate of the men employed in Number 2 mine apart from Number 1 North Level, would be 120, and it was probably less. Assuming that there were 120 men there at the time of the disaster, it will be seen that the quantity of air coming down Number 2 slope would be at least sufficient to allow the required two hundred cubic feet per man that is required by the Act. It is true that this does not take into consideration the fact that there were some horses in the mine at the time, but neither, however, does it take into account the compressed air below Number 3 South Level, nor the air going down the new slant. On the other hand, if Number 2 mine was all in one district or split, there would be considerably over the required 200 cubic feet per man. Upon the whole it appears that while the Act appears to have been violated so far as employing more than seventy men in a split or district, it is probable that there was a sufficient volume of air in this portion of the mine to allow the requisite amount per man as is required by the Act, and the evidence does not warrant any finding that the noncompliance of the Act in this regard contributed to the explosion.

"It may be taken for granted, I think, that both the ventilating fans were properly working up to the time of the accident. Any stoppage of the electrically driven fan would have been at once noticed by the man in charge of the switchboard at the power house. So far as the evidence goes it does not seem that any notice had been given to the steam driven fan for about half an hour before the occurrence of the explosion. The working of this fan could be heard by the hoistman in the engine house, provided the window of the engine house was open, but the fan itself could not be seen from there. While there is nothing to suggest that this fan was not working at the time of the disaster, and the evidence all goes to show that it was, it does seem that closer oversight should have been kept upon this fan, when its stoppage might cut off the entire ventilation of one portion of the mine. The attachment of an automatic indicator to the fan would avoid any such danger.

"In regard to the turning of the return air from Number 1 North Level down Number 2 slope, the weight of evidence, I think, goes to show that the system of ventilation in this regard, if not absolutely objectionable, was at least not to be commended, but while this is so, there is nothing to show that this practice contributed any to the cause of the explosion. Neither can it be said that the use of compressed air in the workings of Number 2 slope below Number 3 South Level, is accountable in any way for the disaster. It was practically admitted, I think, that the explosion did not originate in this portion of the mine.

"With regard to the operation of a hand fan in Number 1 North Level, and in Number 2 South Level opposite the raises, the evidence shows that the mine had not been working during the two days immediately prior to the day of the disaster, and the evidence of the Examiner, William Adlam, is to the effect that these raises were full of gas. The fan boys who operated the hand fan went into the mine at the same time as the miners, and consequently it is to be presumed that after the miners had begun work, if there were men working at the face of the entries, the gas from the raises would be driven over them, and that such a practice is bad is admitted by a number of expert witnesses. So far as the question concerns Number 1 North Level, it is of no importance, as there was no explosion in that part of the mine, and in regard to Number 2 South Level, it must be remembered the fan would start to expel the gas from the raise when the morning shift went on, that is at seven o'clock in the morning, and the explosion did not occur until two and a half hours afterwards. There is again nothing, I think, to show that the explosion originated at this point, nor, I think, did any of the witnesses so contend. And as to the general practice of using these fans, under such conditions, it must be said that Mr. Hudson, representative of the Dominion Department of Mines, and a man of wide experience in mining matters, was unwilling to criticize their use.

"It appears from the evidence, that while the system of ventilation in some details has, and I think, with some reason, been criticized by some of the witnesses giving evidence at the inquiry, so far as the men of the mine were concerned, there seems to have been only one opinion in regard to the ventilation and that was, that the ventilation was good so far as their own particular working places were concerned. There was apparently no complaint whatever by the men in that regard.

"It is true that a month or more before the disaster the conditions were not so good. Evidence was given that travelling caps, that is the existence of such an amount of gas in the ventilating current as would show a flame in a test with a safety lamp, were found. But this condition was before the driving through of Room 31, and upon the completion of that work, this condition was remedied. Since that time, and up to the time of the disaster, there had been no complaints on the part of the men, nor had there been anything that would indicate any unsatisfactory condition in the ventilation of the mine. The report of the Pit Committee, representing the miners, made on the 18th of May, just a month before the disaster, sets out that they found the ventilation good and general conditions good, and the evidence is to the effect that between that time and the time of the disaster there were no circumstances that would lead any one to believe that the condition of the mine had, in the meantime, undergone any change. Notwithstanding the fact, therefore, that the system of ventilation is, as I have said before, in a number of details open to criticism, the evidence does not warrant me, I think, in attributing the cause of the explosion to any faulty ventilation of the mine.

"The question of gas in the mine must be intimately connected with the question of ventilation. At the same time the presence of gas is not necessarily an indication of an inefficient system of ventilation. The accumulation of gas may arise from the fact that the brattices have not been led up sufficiently to the faces of the workings and consequently the air current is not conducted sufficiently near the faces so as to carry away the gas. And in a mine of this nature it may be said that generally there is always more or less gas.

"In any mine where inflammable gas has been found within three months, an inspection of the roadways leading through the mine, and the working places must, under the provisions of The Mines Act, be made within three hours before each shift goes to work in the mine. During this inspection a test is made for gas, and the Examiner makes a report as to the condition of the mine, such report being recorded in a book kept for that purpose and a copy of this report is posted up immediately in a conspicuous place at the mine. The last inspection of this nature, made before the explosion, was by the Examiner, William Adlam, who went into the mine about ten minutes to four and came out at twenty minutes past six six o'clock on the morning that the disaster occurred. His report showed the presence of gas in working places 2, 5, 12, 17, 7, 8 and 43. Of these places, 2, 12 and 17 are in the workings of Number 1 North Level, 7 and 8 in Number 3 South Level, and 5 and 43 in Number 2 South Level. The Examiner swears that in accordance with his duties in that regard he fenced off these places so that the miners would not go into them until the gas had been cleared out.

"It is the custom for the brattice men, who attend to the placing of the brattices, so as to conduct the air current up to the working face and so clear those places of gas, to go into the mine a half hour or so before the shift goes in. The Examiner or Examiners on duty at that hour gives or give the orders based upon the report of the Examiner who has just made his inspection. The lamps of the brattice men are examined by the Examiners who have gone on duty, and in this case John Ironmonger swears that he examined the lamps of the brattice men when going into the mine. It is, I think, only fair to assume that the brattice men on this morning went in as customary to attend to the fixing of the brattices so as to rid the mine of the gas indicated in the Examiner's report. If the brattice men attended to their duties, and it is only fair to assume they would do so, the mine, with the exception of the raises, should have been speedily freed of gas.

"I confess that the evidence of Adlam somewhat bewildered me in regard to the quantities of gas referred to in his report. My impression from his evidence given in the first instance was that there were comparatively only small quantities of gas in the places indicated in his report. Upon his being recalled his evidence gave me the impression that the quantities of gas were much greater than his evidence led me to believe in the first instance, and I am somewhat at a loss to reconcile his different statements in this regard. Adopting his later statement, it is evident that the raise in Number 1 North Level, and the raise in Number 2 South Level, were, as he says, full of gas. With these raises full of gas it does seem that it would have been advisable that these places should have been cleared before the miners entered the mine. Such a course at least would have avoided an element of danger that had to exist if the raises were being cleared after the miners had gone to work. Notwithstanding, however, that the gas was in the quantities I have mentioned, Adlam says that he did not consider that there was an unusual amount of gas in the mine that morning, and Mr. Hudson, who heard all the evidence, expressed his opinion that nothing indicated an undue amount of gas at that time.

"The theory of Mr. Fraser was that the explosion originated in the workings of Number 2 South Level. If such were the case, except so far as it would tend to vitiate the air current going through Number 2 South, the gas in all the working places but 5 and 43 may be eliminated so far as this phase of the investigation is concerned. The mine had been idle on the 17th and 18th of June, the two days immediately before the day of the disaster, but the ventilation system, with the exception of the working of the hand fans, was in full operation, and a perusal of the Examiners' reports for those days shows the mine to have been more than ordinarily free of gas during that time. There does not seem to be anything in the evidence in regard to the presence of gas in the mine that assists in leading to any conclusion as to the cause of the disaster, nor to lead to condemnation of the general system of ventilation then in use in the mine.

"One of the great sources of danger in a mine lies in the presence of dust, provided that dust is of a sufficiently explosive or inflammable nature. The really dangerous dust is the fine impalpable dust that clings to the roof and walls and timbers used throughout the mine. This may, if of a sufficiently explosive character, be ignited by a blown-out shot or by contact with a flame of sufficiently high temperature. In the course of an explosion it generates its own gas and will rapidly spread through a mine where there is sufficient dust to feed the explosion, but the dust, if sufficiently wet, loses for the time being its explosive character.

"In regard to the character of the dust in the Hillcrest mine, both counsel for the mine owners and the miners at the inquiry agreed that I should avail myself of the result of the tests made by the United States Bureau of Mines as to the explosibility of samples of dust taken from the Hillcrest mine. Without adopting any technical language, it may be said that these tests show that the dust in this mine is of a fairly highly explosive character and the dust would ignite by a blown-out shot or by an ignited pocket of gas. It may be said that the general supposition of practically all of the witnesses at the inquiry was that the dust was of this character, so that the evidence has all been given based upon this supposition, which has now been confirmed by these tests.

"As to the quantity of dust in the mine, the evidence is to some extent conflicting. Mr. Aspinall, who was the Government Inspector of Mines for the district in which the Hillcrest mine is situated, a year or so prior to the disaster, stated that he would consider this a fairly dusty mine, and in his report of the 4th of July last year calls attention to the fact that there was considerable dust in certain places in the mine, but apparently the only immediate danger that was anticipated from the presence of this dust was from shot-firing, and it seems that shot-firing was discontinued in the places complained of. On the other hand the evidence of nearly all of the men working in the mine who gave evidence was to the effect that prior to the explosion they would not consider this a dusty mine.

"With the exception of Number 1 slant, the main roadways are more or less wet. Number 1 North Level may be said to be distinctly wet, and so with Number 2 slope below Number 2 South Level, and this may also be said to apply to the northern part of Number 2 South Level. One of the means adopted to prevent the spreading of the dust explosions in a mine is by the watering of and keeping damp the main roadways in a mine, although this system is not universally approved of, as nothing but the thorough soaking of the dust eliminates the danger. This system of dealing with the dust, however, has not been adopted in any of the Western Provinces, and it cannot be said therefore that the company failed in their duty in not adopting such a course. The main roadways, as I have just said, were with some exceptions, wet, and it seems to have been the general opinion that the watering of the rooms and the working faces would be impracticable.

"I do not think that the evidence is such as to show that the company had any reason to believe that there was a dangerous quantity of dust in this mine. At the same time it must be remembered that an explosion such as occurred on the 19th of June, would undoubtedly increase this dust, and undoubtedly means should be adopted now by the company to eliminate as far as possible the danger from this dust by removing it as far as practicable from the mine or adopting any precautions that can be adopted to prevent the spreading of a dust explosion should it occur. It is needless, I think, to say that the greatest care should now be exercised in regard to shot-firing in the mine. A blown-out shot, as has been pointed out, is the one means of igniting dust directly, and blown-out shots are by no means uncommon in a mine. It is very questionable whether shot-firing should not be entirely eliminated from this mine until the conditions in regard to dust are very much improved from what they were at the time of this inquiry.

"Some criticism was made by Mr. Fraser in regard to the kind of stoppings that were adopted by the management of this mine. It was suggested that had the stoppings been of a more permanent nature the explosion would not have spread to the extent that it did. This, however, seems to be a debatable question, and the evidence shows that the stoppings in this mine were of the same character as are used in the mines throughout the Western Provinces. There is nothing in the evidence to lead me to the conclusion that if the stoppings had been of a different character the extent of the explosion would have been curtailed. There is evidence indeed to the effect that substantial stoppings by first confining the forces developed by the explosion might have eventually rendered the disaster greater even than it was.

"Apart from the matters I have already dealt with, there does not appear to be anything in connection with the management of the mine, nor in the care taken by the company in its operations that could have led or contributed in any way to the disaster.

"The initial cause of the explosion does not appear to be ascertainable. I have, almost at the outset of this report, mentioned the ordinary causes of ignition of gas in a mine. Shot-firing having been eliminated, the explosion must of course have originated from the ignition of gas, but by what means there has been absolutely no suggestion. Certain of the ordinary causes of ignition have been or may be eliminated here, but there is no means whatever of fixing upon which of the remaining causes it was that started the explosion.

"As to its character, Mr. Drinnan was of the opinion that it was almost entirely a gas explosion, and that dust contributed very little if any to it. With this exception, however, the expert witnesses all were of the opinion that it was a gas explosion augmented by the ignition of dust and that dust played a considerable part if not the greatest part in the explosion. The finding of a very considerable amount of coked coal dust was one of the facts that was relied upon by those who advanced this latter theory, and in view of the result of the tests of the dust I think this view is the most reasonable one to adopt.

"It is impossible also to determine the seat or place of origin of the explosion. Mr. Fraser expressed the opinion that it occurred in the workings above Number 2 South Level, but he is unable to point out any exact locality. The other experts were unable to come to any conclusion in this regard. In certain parts of the mine it can be said that the explosion did not originate, but apparently the place where it did originate cannot be determined.

"It will be seen from the foregoing portions of this report, that the course adopted by the management of the mine in relation to the ventilation thereof, and other matters closely related to the question of ventilation, was apparently either objectionable or at least open to criticism, but the evidence does not go so far as to show that this was responsible for the disaster. And it must be said that Mr. Hudson stated that he would not attempt to criticize the ventilation of any mine from the plan, and without having the advice of the men who are conducting the ventilation from day to day. As one of the witnesses states it, so far as this explosion is concerned, something must have happened in the mine of which we have no evidence.

The only conclusion, therefore, that I can arrive at, as a result of the whole evidence adduced at the inquiry is that the disaster was caused by an explosion of gas, the origin and seat of which is unascertainable, this explosion being augmented by the ignition of dust throughout the mine.

"Although the cause of the explosion cannot be determined, a consideration of the facts and circumstances brought out by the evidence at the inquiry suggests certain recommendations which, it is submitted, may lessen the extent of the danger that was shown to be attendant upon the operation of this mine. Most of these have already been suggested in this report.

"Attention has been called to the fact that the Number 2 fan was without direct supervision for about half an hour before the occurrence of the explosion, and it has been pointed out that the stopping of the fan for any considerable length of time might be attended with serious consequences. It is suggested that such a fan should be either under the constant supervision of some one or should have an automatic indicator attached thereto in lieu of such personal supervision.

"The question of shot-firing in the mine has also been already discussed. It is suggested that, until the danger from dust in this mine is considerably reduced, shot-firing should be either discontinued entirely or that the men be withdrawn from the mine during such firing.

"A recommendation in regard to the search of the employees, at stated intervals, for matches, pipes and tobacco, has, I understand, already been made by the coroner's jury in connection with this disaster. It can be only added that where the personal equation must be so largely a factor in the safety of a mine, too great care cannot be exercised in such a matter as this.

"Two further recommendations which do not immediately deal with the safety of the men employed in the mine are suggested. The difficulty arising from the absence of a plan of the ventilation system of a mine at the inquiry has already been referred to. And it has been pointed out that under the British Coal Mines Act the operators are required to keep such a plan in their office. It is suggested that a similar provision be inserted in our own Act. The difference of opinion existing in regard to the definition of a district or split has also been referred to. I have already indicated my own view in regard to the question, but it is suggested that a definition of the term be inserted in our Act, so that no difference of opinion can possibly, or at least reasonably, arise.

A. A. CARPENTER,

"CALGARY, October 20, 1914." *Commissioner."*

DRAUGHTING DIVISION.

H. E. Baine.

Chief of Division.

The staff of this division consists of a chief officer, two map compilers, two assistant map draughtsmen, and a mechanical draughtsman.

During the year, some 49 maps were compiled and published, together with 200 mechanical drawings, charts, etc.

The blue print machine installed by the Mines Branch has given every satisfaction; some 1,200 prints having been made and supplied during the year.

The following is a list of maps, mechanical drawings, diagrams, etc., prepared during the calendar year 1914. The name of the officer for whom they were prepared will be found in the margin:—

Dr. Parks.—

Building stones, Vol. III.

Map of the Province of Quebec, showing the chief belts.
Map of the Province of Quebec, showing the chief slate quarries.
3 drawings.

E. Lindeman.—

Iron Ore Deposits of Nova Scotia.

Magnetometric map, McPherson mine, Barachois, Cape Breton county, Nova Scotia.
Magnetometric map, Upper Glencoe, Inverness county, Nova Scotia.
Magnetometric map. Grand Mira, Cape Breton county, Nova Scotia.
2 geological sections.

A. W. G. Wilson.—

Copper Smelting Industry of Canada.

42 diagrams, charts, etc., to accompany report on copper.

B. F. Haanel.—

Peat, Lignite, and Coal.

50 mechanical drawings, charts, etc.

S. C. Ells.—

Bituminous Sands of Alberta.

Map of northen portion of Alberta, showing position of outcrops of bituminous sands.
6 drawings, charts, etc.

John McLeish.—

Mineral Map of Canada, to accompany "Economic Minerals and Mining Industries of Canada".

H. T. Kalmus.—

Metallic Cobalt Research Series, Vol. II.

16 drawings, charts, etc., to accompany report on "The Physical Properties of the Metal Cobalt".

G. C. Mackenzie.—

Magnetic Iron Sands of Natashkwan.

Map of Natashkwan magnetic iron sands Saguenay county, Quebec.
15 drawings, charts, etc.

Hugh S. de Schmid.—

10 small maps, 37 diagrams, charts, etc., to accompany report on "Phosphate."

Summary Report, 1914.—

2 maps, 13 drawings, charts, etc.

L. H. Cole.—

Salt Industry of Canada.

Map showing saline springs and salt areas of the Dominion of Canada.
Map showing saline springs and salt areas in the Maritime Provinces.
Map of the Michigan-Ontario salt basin.
Map showing saline springs in northern Manitoba.
13 small maps and 13 diagrams, charts, etc.

F. G. Clapp.—

Petroleum and Natural Gas Resources of Canada.

Map of Dominion of Canada, showing the occurrence of oil, gas and tar sands.
Map showing gas and oil fields and pipe lines in southwestern Ontario.
Map showing location of main gas line, Bow island, Calgary.
48 geological sections.

Aleph von Anrep.—

Peat bog maps:—
Sunderland peat bog, Brock township, Ontario county, Ontario.
Amaranth peat bog, Amaranth township, Dufferin county, Ontario.
Manilla peat bog, Mariposa township, Victoria county, Ontario.
Cargill peat bog, Greenock township, Bruce county, Ontario.
Clareview peat bog, Sheffield township, Lennox and Addington counties, Ontario.
Westover peat bog, Beverly township, Wentworth county, Ontario.
Stoco peat bog, Hungerford township, Hastings county, Ontario.
Richmond peat bog, Goulbourn and Marlborough townships, Carleton county, Ontario.
Luther peat bog, townships of Luther, East and West, Wellington and Dufferin counties, Ontario.
Marsh Hill peat bog, Reach and Brock townships, Ontario county, Ontario.
Mermaid peat bog, Bedford township, Queens county, Prince Edward Island.
The Black Banks peat bog, Halifax township, Prince county, Prince Edward Island.
43 drawings, charts, etc.

REPORT COVERING THE OPERATIONS OF THE DOMINION OF CANADA ASSAY OFFICE, VANCOUVER, B.C., DURING THE YEAR ENDING DECEMBER 31, 1914.

Dr. Eugene Haanel,
Director of Mines,
Ottawa, Ont.

Sir,—I have the honour to submit herewith report covering the operations of the Dominion of Canada Assay Office, Vancouver, B.C., for the calendar year ending December 31, 1914, accompanied by statements showing Assayers' and Melters' supplies on hand.

CHANGES IN STAFF.

R. Allison, janitor, appointed assistant melter, June 20, 1914.

E. A. Pritchett, appointed janitor, June 20, 1914, vice R. Allison.

R. D. McLellan, appointed general assistant, June 29, 1914, left the service September 11, 1914.

H. E. Warburton, appointed temporary clerk, July 4, 1914, called out for military duty August 10, 1914, left the service October 3, 1914.

DETAILED STATEMENT.

There were 1,112 deposits of gold bullion, requiring 1,300 melts and 1,300 assays (quadruplicate check assays being made in each instance) including the assembling and remelting of the individual deposits after purchase into bars weighing about 1,000 troy ounces and the assaying of same. The aggregate weight of the deposits before melting was 166,148·83 troy ounces, and after melting 163,543·62 troy ounces showing a loss in melting of 1·5680 per cent. The loss in weight by assaying was 20·01 troy ounces (base and parted silver), the average fineness of the resulting bullion, viz: 163,523·61 troy ounces, being ·594½ gold and ·308 silver. The net value of the gold and silver contained in deposits was $2,029,251.31.

The gold bullion received came from the following sources, viz.:—

Source.	Number of deposits.	Before melting.	Weight after melting.	Net value.
		(troy ounces.)	(troy ounces.)	$
British Columbia	893	109,037·86	106,591·28	1,105,489 01
Yukon Territory	209	56,720·31	56,567·34	916,914 44
Alberta	1	30·08	29·70	511 55
Alaska	9	360·58	355·30	6,336 31
	1,112	166,148·83	163,543·62	2,029,251 31

Weight before melting .... 166,148·83 troy ounces.
Weight after melting .... 163,543·62 " "

2,605·21 " "

Loss percentage by melting .... 1·5680 %.

CREDITS AND DISBURSEMENTS FOR THE PURCHASE OF GOLD BULLION DURING THE YEAR ENDING DECEMBER 31, 1914.

Unexpended balance,—"Letters of Credit," January 1, 1914.		$ 117,486 33
Credits established during year ending December 31, 1914..		2,000,000 00
"Letter of Credit" balance written off at close of fiscal year, March 31, 1914..	$ 43,531 30	
Disbursements for the purchase of bullion..	2,029,251 31	
Unexpended balance,—"Letter of Credit," December 31, 1914..	44,703 72	
	$2,117,486 33	$2,117,486 33

DISBURSEMENTS FOR THE PURCHASE OF GOLD BULLION AND RECEIPTS FROM SALE DURING THE YEAR ENDING DECEMBER 31, 1914.

Disbursements for the purchase of bullion on hand January 1, 1914, bars Nos. 656, 678 to 687 inclusive..		$ 28,425 48
Disbursements for the purchase of bullion during the year ending December 31, 1914, per cheques Nos. 499 to 598 inclusive (omitting No. 499 cancelled) and Nos. 1 to 705 inclusive..		2,029,251 31
Proceeds from sale of bullion during year ending December 31, 1914..	$2,022,790 86	
Value of bullion on hand December 31, 1914, bars Nos. 951 to 994 inclusive..	36,918 09	
Difference in favour of this office..		2,032 16
	$2,059,708 95	$2,059,708 95

CONTINGENT ACCOUNT FOR YEAR ENDING DECEMBER 31, 1914.

Unexpended balance, January 1, 1914..		$ 0 63
Funds provided for Official cheques No's 1540, 1692, 1843, 9, 132, 361, 593, 785, 982, 1139, 1275, and 1444..		4,099 00
Amount remitted, Receiver-General per draft No. 15 at close of fiscal year, March 31, 1914..	$ 32 34	
Expenditure during year ending December 31, 1914..	4,055 55	
Unexpended balance, December 31, 1914..	11 74	
	$ 4,099 63	$ 4,099 63

CONTINGENT EXPENDITURE DURING YEAR ENDING DECEMBER 31, 1914.

Fuel (gas)..	$ 583 35
Power..	231 35
Express charges on bullion..	1,673 55
Electric vault protection..	300 00
Postage..	35 00
Telephones..	79 90
Duty, expressage, freight, etc., on supplies..	31 57
Assayers' and melters' supply (purchased locally)..	686 33
Electric drill..	38 00
Button balance..	220 00
Sundries..	176 50
	$4,055 55

PROCEEDS FROM RESIDUES SOLD.

Residue sold to United States Assay Office, Seattle, Wash., U.S.A., (Bar No. A-8)..	$ 872 51
24 empty acid bottles sold to B.C. Assay and Chemical Supply Co., Limited, March, 1914..	2 88
	$ 875 39

RESIDUES ON HAND, DECEMBER 31, 1914.

Recovered from slags, sweepings, old furnaces, old crucibles, etc., 65·21 ounces gold bullion, value..	$ 831 65
36 empty acid bottles.	

Miscellaneous Receipts.

Draft No. 42, in favour of Deputy Minister of Mines (a payment for crushing and melting 1,352·62 ounces quartz)..	$ 40 00
Draft No. 49, in favour of Deputy Minister of Mines (a payment for treating 25 pounds slag)..	9 50
	$ 49 50

The following shows the business done by the Assay Office during the past five years, viz.:—

Calendar Year.	Number of deposits.	Weight.	Net Value.
		(troy ounces)	$
1910	490	46,064·31	746,101 92
1911	442	39,784 70	647,416 38
1912	527	59,068·83	974,077 14
1913	783	111,479·95	1,448,625 37
1914	1,112	166,148·83	2,029,251 31

I have the honour to be, sir,
Your obedient servant,
G. MIDDLETON,
Manager.

December 31, 1914.

G. Middleton, Esq.,
Manager, Dominion of Canada Assay Office,
Vancouver, B.C.

Sir,—I beg to report the following assayers' supplies on hand at above date, viz.:—

Silver nitrate crystals..	¾ oz.
Calcic chloride..	2 "
Lead foil, C. P..	88 lb.
" granulated, C. P..	2 "
Zinc, mossy, C. P..	½ "
Litharge..	1 "
Copper wire..	1 spool.
Acid, nitric, C. P..	3½ Winchesters.
" hydrochloric, C. P..	½ Winchester.
" sulphuric, C. P..	¼ "
Ammonia..	½ "
Small clay crucibles..	13 only.
Scorifiers, 4-inch..	1
" 2½-inch..	55
Spare mufflers..	22
" doors..	2
" supports..	6
" back stops..	15
Bone ash..	15 lb.
Cupels..	5,966
Gold cornets..	·33 oz.
" in solution..	22·56 "
" proof..	12·35 "
Silver..	224·77 "

Your obedient servant,
J. B. FARQUHAR,
Chief Assayer.

December 31, 1914.

G. MIDDLETON, Esq.,
Manager, Dominion of Canada Assay Office,
Vancouver, B.C.

SIR,—I beg to inform you that we have the following supplies on hand in the Melting Department, viz.:—

2 sets of linings, with supports and covers complete for No. 2 furnace.
4 " " " 4½ "
5 " " " 7 "
6 graphite crucibles, No. 6.
2 " " 14.
40 " " 16.
3 " " 30.
6 " " 40.
35 " " marked ⁘
2 crucible covers, No. 6.
5 " " 14.
3 " " 30.
8 lb. sodium nitrate.
25 " borax glass.
20 " carb. soda.

Your obedient servant.
D. ROBINSON,
Chief Melter.

ACCOUNTANT'S STATEMENT, 1913-14.

The following is a statement of the difference in value of assays between Seattle Assay Office and Dominion of Canada Assay Office between April 1, 1913, and March 31, 1914:—

Paid for bullion at Dominion of Canada Assay Office, Vancouver.	$1,456,468 70
Received for bars from United States Assay Office, Seattle.. ..	1,457,653 11
Difference in favour of Dominion of Canada Assay Office.. ..	$ 1,184 41

STATEMENT OF DEPOSITS OF GOLD AND EARNINGS.

Deposits of gold..		$1,457,653 11
Earnings:—		
Melting 28·72 oz. bullion for J. Greer..	$ 1 50	
Treating 26·38 pounds slag for John Hopp..	13 10	
Value of 24 empty jars sold B.C. Assay and Chemical Supply Co.	2 88	
Value of residue sold United States Assay Office..	872 51	
	889 99	
Difference between amounts paid and received for bullion..	$ 1,184 41	
	$ 2,074 40	

STATEMENT OF DEPOSITS OF GOLD AND EARNINGS.

The following is a statement of the appropriation, receipts and expenditure of the Dominion of Canada Assay Office for the year ending March 31, 1914, and shows the unexpended balance to be $12,131.17.

	Appropriation.	Expenditure.
Appropriation, 1913-1914..	$ 27,000 00	
Receipts per the foregoing statement..	889 99	
Difference between amounts paid and received for bullion..	1,184 41	
Fuel..		403 30
Power and light..		197 12

	Appropriation.	Expenditure.
Postage and telegrams..		93 19
Telephone..		78 00
Express charges..		1,203 11
Assayer's supplies..		747 33
Printing and stationery..		190 47
Premium on bonds..		600 00
Contingencies..		137 16
Electric burglar alarm service..		300 00
Wages:—		
G. Middleton..		2,650 00
J. B. Farquhar..		1,900 00
H. Freeman..		1,500 00
D. Robinson..		1,575 00
A. Kaye..		1,800 00
G. N. Ford..		1,500 00
R. Allison..		975 00
F. W. Taylor..		200 00
T. B. Younger..		893 55
Balance unexpended and lapsed..		12,131 17
	$ 29,074 40	$ 29,074 40

ACCOUNTANT'S STATEMENT, 1914-15.

The following is a statement of the difference in value of assays between Seattle Assay Office and Dominion of Canada Assay Office between April 1, 1914, and March 31, 1915:—

Paid for bullion at Dominion of Canada Assay Office, Vancouver..	$2,105,136 12
Received for bars from United States Assay Office, Seattle..	2,107,334 40
Difference in favour of Dominion of Canada Assay Office..	$ 2,198 28

STATEMENT OF DEPOSITS OF GOLD AND EARNINGS.

Deposits of gold..		$2,107,334 40
Earnings:—		
Crushings and melting 1,352·62 ounces quartz for A. A. Logan...	$ 40 00	
Treating 25 pounds slag for John Hopp..	9 50	
Value of 48 empty acid bottles sold B. C. Assay and Chemical Supply Co..	5 76	
Value of residue sold United States Assay Office..	993 70	
		$ 1,048 96
		$ 2,198 28
		$ 3,247 24

The following is a statement of the appropriation, receipts and expenditure of the Dominion of Canada Assay Office for the year ending March 31, 1915, and shows the unexpended balance to be $4,044.12:—

	Appropriation.	Expenditure.	Unexpended Balance.
Maintenance of Assay Office, Vancouver, B.C..	$ 20,000 00	$ 15,955 88	$ 4,044 12

	Appropriation.	Expenditure.
Appropriation, 1914-15..	$ 20,000 00	
Receipts per the foregoing statement..	1,048 96	
Difference between amounts paid and received for bullion..	2,198 28	
Fuel..		625 75
Power and light..		244 19
Postage and telegrams..		134 17
Telephone..		79 90
Express charges..		1,780 58

	Appropriation.	Expenditure.
Assayer's supplies..		847 17
Printing and stationery..		106 10
Premium on bonds..		610 45
Contingencies..		152 85
Electric burglar alarm service..		300 00
Wages:—		
G. Middleton..		2,650 00
J. B. Farquhar..		1,900 00
A. Kaye..		1,800 00
H. Freeman..		1,500 00
D. Robinson..		1,575 00
R. Allison..		1,056 96
G. N. Ford..		1,500 00
T. B. Younger..		1,200 00
E. A. Pritchett..		702 50
H. E. Warburton..		255 00
A. D. McLellan..		182 50
Balance unexpended..		4,044 12
	$ 23,247 24	$ 23,247 24

LIST OF REPORTS, BULLETINS, ETC., PUBLISHED DURING THE YEAR 1914.

S. GROVES.

Editor, Department of Mines.

No. 105. Austin Brook Iron-bearing District, New Brunswick. By E. Lindeman, M.E Published January 7, 1914.

203. Building and Ornamental Stones of Canada. Vol. II: Maritime Provinces. By Wm A. Parks, Ph.D. Published July 22, 1914.

209. Copper Smelting Industries of Canada. By Alfred W. G. Wilson, Ph.D. Published September 24, 1914.

222. Lode Mining in Yukon: An Investigation of Quartz Deposits in the Klondike Division. By T. A. MacLean, M.E. Published September 25, 1914.

245. Gypsum in Canada: Its Occurrence, Exploitation and Technology. By L. H. Cole, B.Sc. Published December 10, 1914.

254. Magnetite occurrences near Calabogie, Renfrew County, Ontario. By E. Lindeman M.E. Published August 8, 1914.

257. The Production of Cement, Lime, Clay Products, Stone, and other structural materials in Canada, during the calendar year 1912. By John McLeish, B.A. Published January 24, 1914.

259. Preparation of Metallic Cobalt. By Herbert T. Kalmus, B.Sc., Ph.D. Published April 6, 1914.

262. Annual Report on the Mineral Production of Canada, during the calendar year 1913 By John McLeish, B.A. Published March 6, 1914.

283. Preliminary Report on the Mineral Production of Canada, during the calendar year 1913. By John McLeish, B.A. Published March 3, 1914.

303. Moose Mountain Iron-bearing District, Ontario. By E. Lindeman, M.E. Published August 18, 1914.

316. The Production of Coal and Coke in Canada, during the calendar year 1913. By John McLeish, B.A. Published December 3, 1914.

322. Economic Minerals and Mining Industries of Canada. Panama-Pacific Edition Published December 31, 1914.

List of Mines Branch Reports, Bulletins, Maps, etc. Published February 14, and May 14, 1914.

Price list of Special Technical Reports. Published May 14, 1914.

FRENCH TRANSLATIONS PUBLISHED DURING THE YEAR 1914.

M. SAUVALLE.

Chief of Publishing and Translating Division.

No. 971. (26a) French translation: Annual Report on the mining industries of Canada for the calendar year 1905. Published in 1914.

(26a) French translation: General Summary Report of Mines Branch for 1913. Published July, 1914.

56. French translation: The Bituminous, or Oil-shales, of New Brunswick and Nova Scotia, also on the Oil-shale industry in Scotland. By R. W. Ells, LL.D. Published August 6, 1914.

100a. French translation: The Building and Ornamental Stones of Canada: Building and Ornamental Stones of Ontario. By W. A. Parks, Ph.D. Published January 26, 1914.

149. French translation: Magnetic Iron sands of Natashkwan, Saguenay County, Que. By G. C. Mackenzie, B.Sc. Published September, 1914.

169. French translation: Pyrites in Canada: its occurrence, exploitation, dressing and uses. By A. W. G. Wilson, Ph.D. Published September 24, 1914.

195. French translation: Magnetite occurrences along the Central Ontario railway. By E. Lindeman, M.E. Published September, 1914.

219. French translation: Austin Brook Iron-bearing District. By E. Lindeman, M.E Published September 29, 1914.

263. French translation: Recent advances in the construction of electric furnaces for the production of pig-iron, steel and zinc. Bulletin 3. By Eugene Haanel, Ph.D. Published November 16, 1914.

264. French translation: Mica, its occurrence, exploitation, and uses. By Hugh S. de Schmid, M.E. Published July 9, 1914.

265. French translation: The mineral production of Canada for 1911. Published August, 1914.

288. French translation: Production of Coal and Coke of Canada, during the calendar year 1912. By John McLeish, B.A. Published December 31, 1914.

290. French translation: Production of Copper, Gold, Lead, Nickel, Silver, Zinc and other metals of Canada during the calendar year 1912. By C. T. Cartwright. Published November 1, 1914.

307. French translation: Catalogue of French publications of the Department of Mines. Published July 1, 1914.

308. French translation: Investigations of Coals in Canada. Volume I. By J. B. Porter, Ph.D., and others. Published November 1, 1914.

ACCOUNTANT'S STATEMENT MINES BRANCH.

STATEMENT OF APPROPRIATING AND EXPENDITURE, 1913-14.[1]

Mines Branch.	Grant.	Expenditure.	Grant not used.
Investigation of ore deposits, economic minerals, peat bogs, determination of fuel values of coals, lignite and peat of Canada, including wages of machinist and labourers, and additional machinery; investigation of ore dressing, including wages of labourers, machinery and equipment of laboratory; collection of information regarding minerals, and metallurgical industries and operations	$ 77,000 00	$ 54,799 29	$ 22,200 71
Publication of reports, translation of reports into French, purchase of books, stationery, chemical laboratories' expenses, apparatus, instruments, office contingencies, additional assistance	69,500 00	69,030 90	469 10
Investigation of metallurgical problems of economic importance	10,000 00	9,999 86	0 14
For apparatus and equipment, salaries of inspectors, chemists, machinist, clerical assistance, and travelling expenses in connexion with the investigations of the manufacture and storage of explosives in Canada	55,000 00	480 24	54,519 76
Zinc investigations per Bill No. 182	34,266 77	30,948 99	3,317 78
Investigation of quartz and copper deposits in the Yukon	9,000 00	8,620 36	379 64
	$ 254,766 77	$ 173,879 64	$ 80,887 13
DOMINION OF CANADA ASSAY OFFICE, VANCOUVER, B.C.			
Maintenance of Assay Office, Vancouver, B.C.	27,000 00	14,868 83	12,131 17

(Signed) JNO. MARSHALL,

May 22, 1914. *Accountant.*

STATEMENT OF APPROPRIATION AND EXPENDITURE BY MINES BRANCH FOR YEAR ENDING MARCH 31, 1914.

	Appropriation.	Expenditure.
Amounts voted by Parliament	$ 329,341 77	
Receipts for Assays and Analyses	377 85	
Civil List Salaries		$ 68,199 86
Publication of Reports		46,564 75
Zinc Investigations		28,613 58
Fuel Testing Plant, Ottawa		15,782 82
Concentrating Laboratory		15,775 53
Metallurgical Investigations		9,999 86
Quartz Investigations		8,620 36
Printing, stationery, books, mapping material		8,242 66
Investigation of Iron Ore deposits		7,876 67
Wages, outside service		5,916 41
Laboratory		3,358 99
Investigation of Peat and Coal		3,213 71
International Geological Congress		2,627 89
Investigation of Tar Sands		2,610 57
Monograph on Petroleum and Natural Gas		2,002 85
Miscellaneous		1,985 04
Investigation of Copper deposits		1,828 51
Publication of Maps		1,663 36
Monograph on Building Stones		1,428 89
Instruments		668 18
Travelling Expenses		655 08
Investigation of Explosives		480 24
Monograph on Mica		450 60

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[1] This fiscal year ends March 31, 1914.

	Appropriation.	Expenditure.
Mineral Statistics..		$ 404 90
Investigation of Salt Deposits..		351 23
Coal Tests..		239 24
Legal Fees..		215 00
Investigation of Oil Shales..		155 16
Investigation of ore deposits..		135 80
Investigations of Manufacturer's Raw Materials..		54 20
Balance unexpended..		89,597 68
	$ 329,719 62	$ 329,719 62

Summary.	Vote.	Expenditure.	Unexpended Balance.
Civil Government Salaries..	$ 74,575 00	$ 68,199 86	$ 6,375 14
Investigation of ore deposits, economic minerals, etc..	77,000 00	54,799 29	22,200 71
Printing, books, stationery, apparatus, chemical laboratories' expenses, miscellaneous..	69,500 00	69,030 90	469 10
Investigation of metallurgical problems of economic importance..	10,000 00	9,999 86	0 14
Investigation of manufacture and storage of explosives in Canada..	55,000 00	480 24	54,519 76
Investigation *re* quartz and copper deposits in Yukon..	9,000 00	8,620 36	379 64
Zinc investigation, per Bill 182..	34,266 77	28,613 58	5,653 19
	$ 329,341 77	$ 239,744 09	$ 89,597 68

ACCOUNTANT'S STATEMENT MINES BRANCH.

STATEMENT OF APPROPRIATIONS AND EXPENDITURE, 1914-15.[1]

Mines Branch.		Grant.	Expenditure.	Grant not used.
Investigation of ore deposits, economic minerals, peat bogs, determination of fuel values of coals, lignite and peat of Canada, including wages of machinist and labourers, and additional machinery; investigation of ore dressing, including wages of labourers, machinery and equipment of laboratory; collection of information regarding minerals, and metallurgical industries and operations..		$ 91,000 00	$ 66,913 79	$ 24,086 21
Publication of reports, translation of reports into French, purchase of books, stationery, chemical laboratories' expenses, apparatus, instruments, office contingencies, additional assistance.. ..		69,500 00	69,498 10	1 90
Investigation of metallurgical problems of economic importance..		10,000 00	10,000 00	
For apparatus and equipment salaries of inspectors, chemists, machinist, clerical assistance, and travelling expenses in connexion with the investigations of the manufacture and storage of explosives in Canada..		55,000 00	456 71	54,543 29
Completion of experiments in zinc smelting..		10,000 00	8,831 11	6,822 08
Under Statute: Zinc Investigation: Advance from 1913-14..	$ 2,335 41			
Zinc Investigation: Balance unexpended, 1913-14..	3,317 78			
		5,653 19		
Civil Government Contingencies..		1,500 00	1,042 66	457 34
		$ 242,653 19	$ 156,742 37	$ 85,910 82
DOMINION OF CANADA ASSAY OFFICE, VANCOUVER, B.C.				
Maintenance of Assay Office, Vancouver, B.C..		20,000 00	15,955 88	4,044 12

(Signed) JNO. MARSHALL,

Accountant.

MAY 26, 1915.

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[1] This financial statement covers nine months of the calendar year which is also the period of greatest activity. Therefore it has been deemed advisable to include the financial report most closely associated with the work described in this summary report. The statement for the previous financial year is also published herewith.

Statement of Appropriations and Expenditure by Mines Branch for year ending March 31, 1915.

		Appropriations.	Expenditure
Amounts voted by Parliament:—			
General Appropriations..	$ 238,817 78		
Civil List Salaries..	92,812 50		
Civil Government Contingencies..	1,500 00		
		$ 333,130 28	
Advance from 1913-14, accounted for in 1914-15..		2,335 41	
Receipts for Assays and Analyses..		359 50	
Civil List Salaries..			$ 77,717 97
Civil Government Contingencies..			1,012 66
Wages..			5,810 76
Publication of Reports..			52,372 27
Fuel Testing Plant..			14,486 67
Concentrating Laboratory..			17,540 47
Ceramic Laboratory..			2,708 06
Chemical Laboratory..			1,983 55
Printing, stationery, books, mapping material.. ..			5,712 85
Publication of Maps..			522 50
Miscellaneous..			2,593 56
Instruments..			1,031 42
Investigation *re* Metallurgical Problems..			10,000 00
" Iron Ores..			11,322 61
" Zinc..			8,831 11
" Tar Sands..			8,486 68
" Peat and Coal..			3,308 00
" Mineral Waters..			2,985 09
" Moulding Sands..			1,489 65
" Limestones..			946 17
" Salt Deposits..			505 75
" Non-Metallic Minerals..			504 43
" Quartz..			479 68
" Explosives..			456 71
" Oil Shales..			165 98
" Copper Deposits..			114 70
" Manufacturer's Raw Materials..			62 17
Monograph on Building Stones..			1,489 65
Mining and Metallurgical Industry..			143 47
Mineral Statistics Industry			5 25
Balance unexpended..			101,005 35
		$ 335,825 19	$ 335,825 19

CASUAL REVENUE.

Sales of Publications..	$ 237 42

Summary.		Vote.	Expenditure.	Unexpended Balance.
Civil Government Salaries..		$ 92,812 50	$ 77,717 97	$ 15,094 53
Investigation of ore deposits, economic minerals, etc..		91,000 00	66,913 79	24,086 21
Printing, books, stationery, apparatus, chemical laboratories' expenses, miscellaneous..		69,500 00	69,498 10	1 90
Investigation of metallurgical problems of economic importance..		10,000 00	10,000 00	
Investigation of manufacture and storage of explosives in Canada..		55,000 00	456 71	54,513 29
Completion of experiments in zinc smelting..		10,000 00		
Under Statute: Zinc Investigation: Advance from 1913-14..	$ 2,335 41		11	6,822 08
Zinc Investigation: Balance unexpended, 1913-14..	3,317 78			
		5,653 19		
Civil Government Contingencies..		1,500 00	1,012 66	457 34
		$ 335,465 69	$ 234,460 34	$ 101,005 35

APPENDIX I.

PRELIMINARY REPORT ON THE MINERAL PRODUCTION OF CANADA DURING THE CALENDAR YEAR, 1914.

EUGENE HAANEL, Ph.D.,
Director of Mines.

SIR,—I beg to submit herewith the annual preliminary report on the mineral production of Canada in 1914.

The figures for production in 1914, while subject to revision, are based upon direct returns from mine and smelter operators and are fairly complete.

Special acknowledgments are due to those operators who have promptly furnished reports of their operations during the year.

When complete returns shall have been received the annual report will be prepared containing in greater detail the final statistics as well as information relating to exploration, development, prices, markets, imports and exports, etc.

I am, sir, your obedient servant,

JOHN McLEISH.

Division of Mineral Resources and Statistics,
February 24, 1915.

PRELIMINARY REPORT ON THE MINERAL PRODUCTION OF CANADA, 1914.

Statistics Subject to Revision.

The preliminary report on the mineral production in Canada in 1914 presented herein shows a total value of the production during the year just closed of $128,475,499. The total value of the production in 1913 was $145,634,812, compared with which the 1914 output shows a decrease of $17,159,313, or 11 8 per cent. The average production per capita was $15.91, as against $18.77 in 1913; $18.27 in 1912, and $14.93 in 1910.

The production of the more important metals and minerals is shown in the following tabulated statement in which the figures are given for the two years 1913 and 1914 in comparative form, and the increase or decrease in value shown. Tabulated statements in greater detail will be found on subsequent pages of this pamphlet.

——		1913.		1914.		Increase (+) or Decrease (-) in value.
		Quantity.	Value.	Quantity.	Value.	
			$		$	$
Copper	lb.	76,976,925	11,753,606	75,738,386	10,301,935	- 1,451,671
Gold	oz.	802,973	16,598,923	770,374	15,925,044	- 673,879
Pig-iron	*tons.	1,128,967	16,540,012	783,164	10,002,856	- 6,537,156
Lead	lb.	37,662,703	1,754,705	36,337,765	1,627,568	- 127,137
Nickel	"	49,676,772	14,903,032	45,517,937	13,655,381	- 1,247,651
Silver	oz.	31,845,803	19,040,924	27,544,231	15,097,269	- 3,943,655
Other metallic products		....	1,313,732	....	1,123,919	- 189,813
Total		....	81,904,934	....	67,733,972	- 14,170,962
Less pig-iron credited to imported ores	tons.	1,055,459	15,543,583	687,420	8,863,944	- 6,679,639
Total metallic		....	66,361,351	....	58,870,028	- 7,491,323
Asbestos and asbestic	tons.	161,086	3,849,925	117,573	2,909,806	- 940,119
Coal	"	15,012,178	37,334,940	13,594,984	34,133,108	- 3,901,832
Gypsum	"	636,370	1,447,739	510,663	1,137,157	- 310,582
Natural gas	M. ft.	20,477,838	3,309,381	21,047,028	3,511,302	+ 201,921
Petroleum	bl.	228,080	406,439	214,805	343,124	- 63,315
Pyrites	tons.	158,566	521,181	224,958	735,514	+ 214,333
Salt	"	100,791	491,280	107,038	493,648	+ 2,368
Cement	bl.	8,658,805	11,019,418	7,172,480	9,187,924	- 1,831,494
Clay products		....	9,504,31	....	7,090,898	- 2,413,416
Lime	bush.	7,558,484	1,609,398	6,245,189	1,247,517	- 361,881
Stone		....	5,504,639	....	5,593,485	+ 88,846
Miscellaneous non-metallic		....	4,274, 07	....	3,921,988	- 352,819
Total non-metallic		....	79,273,461	....	69,605,471	- 9,667,990
Grand total		....	145,634,812	....	128,475,499	17,150,313

* Short tons throughout.

In presenting a total valuation of the mineral production as is here given, it should be explained that the production of the metals copper, gold, lead, nickel and silver is given as far as possible on the basis of the quantities of metals recovered in smelters in Canada, or probably recovered from ores exported, and the total quantities in each case are valued at the average market price of the refined metal in a generally recognized market.

The quantities thus given will differ from those which represent metal contents of ore shipped by amounts due (1) to losses in smelting (2) to the "lag" or lapse of time between the ore shipment and its treatment in the smelter. Thus the production of refined lead during the past two years has been very much lower than that reported as contained in ores shipped from the mines, the difference being due both to smelter losses and the large accumulation of ore at the smelter.

The metal miner is usually paid for his product on the basis of the value of the refined metals less a variety of deductions, and in many cases it would be exceedingly difficult to obtain a record of the net value received. It is for this reason and for the facility of comparisons that the refined values are used.

It will be observed that there has been a general falling off in the production of nearly all mine products, the notable exceptions being pyrites, salt, and natural gas. In the case of pyrites there is an increase of about 42 per cent, and about 6 per cent in quantity of salt produced. The number of cubic feet of natural gas produced shows an increase of about 3 per cent, with an increase of over 6 per cent in value.

The falling off in the production of the metals is no doubt to be ascribed in large measure to the conditions resulting from the war. Especially is this true in the case of the metals: copper, nickel, and silver. The cutting off of markets and the closing of metal exchanges with the consequent cessation of market quotations resulted in the almost immediate closing down or restriction of operation at many properties. However, before the close of the year, many of these adverse conditions had been adjusted, although prices had fallen considerably.

The actual quantities of copper and lead produced were but little less than in the previous year; nickel showed a decrease of 8 per cent, and silver of 13·5 per cent in quantity.

The total values, because of lower prices, showed much larger percentage decreases.

The iron industry was undoubtedly affected by industrial conditions of depression, and shows a falling-off of 30 per cent in tonnage of pig-iron made.

The total value of the metallic production in 1914 was $58,870,028 as against $66,361,351, a decrease of $7,491,323 or 11 per cent.

The production of non-metallic products also shows a large falling off in 1914, the total value for the year being $69,605,471, as against $79,273,461 in 1913, a decrease of $9,667,990 or 12·19 per cent.

The decrease is most pronounced in the case of coal, asbestos and gypsum and in those products such as cement, clay products (building brick, sewer pipe, etc.) and lime, generally classed as structural materials, although there was a small increase in the production of stone quarries.

Industrial depression, the culmination of over development and extravagant land speculation, is largely responsible for this sudden reverse, although the asbestos output would be restricted by the disturbance in foreign markets and the coal production would also be affected by the restricted metallurgical operations. Reference has already been made to the increased production of pyrites, salt, and natural gas.

There were also slight increases in the production of white arsenic, feldspar, grindstones, ochres, phosphate and tripolite. Asbestos shows a decrease of 27 per cent in tonnage and 24 per cent in value, coal a decrease of 10 per cent in tonnage and 9 per cent in value, petroleum a decrease of 5·8 per cent in quantity and 15·6 per cent in value, clay products 25 per cent in total value, and lime 17·4 per cent in quantity and 22·5 per cent in value.

Mineral Production by Provinces. 1913 and 1914.

	1913.		1914.	
	Value of production.	Per cent of total.	Value of production	Per cent of total.
	$	%	$	%
Nova Scotia	19,376,183	13·30	17,514,786	13 63
New Brunswick	1,102,613	0·76	1,034,706	0·81
Quebec	13,475,534	9·25	12,259,637	9·54
Ontario	59,167,749	40·63	52,147,973	40·59
Manitoba	2,214,496	1·52	2,428,902	1·89
Saskatchewan	881,142	0·60	710,840	0·55
Alberta	15,054,046	10·34	12,773,669	9·94
British Columbia	28,086,312	19·29	24,202,924	18·84
Yukon	6,276,737	4·31	5,402,062	4 21
Dominion	145,634,812	100·00	128,475,499	100·00

The record of production by provinces given in the above table shows the relative importance of the several provinces in the same order as the previous year. A decreased production is shown in each province with the exception of Manitoba, and in this case the increase is due chiefly to the operation of the new cement mill near Winnipeg by the Canada Cement Company and the inclusion of a more complete record of the production of sands and gravels. Ontario again has the largest output with a value of $52,147,973, or 40·59 per cent of the total, practically the same proportion as in the previous year. British Columbia is second with a value of $24,202,924, or 18·8 per cent of the total; Nova Scotia is third, with a production valued at $17,514,786, or 13·6 per cent; Alberta fourth, with $12,773,669, or 9 94 per cent; Quebec fifth, with $12,259,637, or 9·5 per cent; the Yukon sixth, with $5,402,062, or 4·2 per cent; Manitoba seventh, with $2,428,902, or 1 89 per cent; New Brunswick eighth, with $1,034,706, and Saskatchewan ninth with $710,840, each less than 1 per cent.

Annual Mineral Production in Canada since 1886.

Year.	Value of production.	Value per capita.	Year.	Value of production.	Value per capita.
	$	$ cts.		$	$ cts.
1886	10,221,255	2 23	1901	65,797,911	12 16
1887	10,321,331	2 23	1902	63,231,836	11 36
1888	12,518,894	2 67	1903	61,740,513	10 83
1889	14,013,113	2 96	1904	60,082,771	10 27
1890	16,763,353	3 50	1905	69,078,999	11 49
1891	18,976,616	3 92	1906	79,286,697	12 81
1892	16,623,415	3 39	1907	86,865,202	13 75
1893	20,035,082	4 04	1908	85,557,101	13 16
1894	19,931,158	3 98	1909	91,831,441	13 70
1895	20,505,917	4 05	1910	106,823,623	14 93
1896	22,474,256	4 38	1911	103,220,994	14 42
1897	28,485,023	5 49	1912	135,048,296	18 27
1898	38,412,131	7 32	1913	145,634,812	18 77
1899	49,234,005	9 27	1914	128,475,499	15 91
1900	61,420,877	12 04			

The Mineral Production of Canada in 1914.

Subject to Revision.

Product.		Quantity.	Value.
METALLIC.			$
Copper, value at 13 602 cents per pound	lb	75,738,386	10,301,935
Gold	oz.	770,374	15,925,044
Pig-iron from Canadian ore	* tons.	95,744	1,138,912
Iron ore sold for export	"	60,410	135,300
Lead, value at 4·479 cents per pound	lb.	36,337,765	1,627,568
Nickel, value at 30 cents per pound	"	45,517,937	13,655,381
Silver, value at 54·811 cents per oz.	oz.	27,544,231	15,097,269
Cobalt and nickel oxides	lb.	1,387,101	595,999
Cobalt material and residues			82,620
Zinc ore	tons.	13,140	310,000
Total			58,870,028
NON-METALLIC.			
Actinolite	tons.	119	1,304
Arsenic, white	"	1,737	104,015
Asbestos	"	96,542	2,892,266
Asbestic	"	21,031	17,540
Chromite	"	136	1,210
Coal	"	13,594,984	33,433,108
Corundum	"	548	72,176
Feldspar	"	18,060	70,824
Graphite	"	1,647	107,203
Grindstones	"	4,078	54,497
Gypsum	"	510,663	1,137,157
Magnesite	"	358	2,240
Manganese	"	28	1,120
Mica	"		102,315
Mineral pigments—			
Barytes	"	612	6,129
Ochres	"	5,890	51,725
Mineral water			122,574
Natural gas	M. cu. ft.	21,047,028	3,511,302
Peat	tons.	685	2,470
Petroleum	bl.	214,805	343,124
Phosphate	tons.	954	7,275
Pyrites	"	224,956	735,514
Quartz	"	54,148	83,583
Salt	"	107,038	493,648
Talc	"	10,808	40,418
Tripolite	"	650	13,000
Total			43,407,737
STRUCTURAL MATERIALS AND CLAY PRODUCTS.			
Cement, Portland	bl.	7,172,480	9,187,924
Clay products—			
Brick, common, pressed, paving			4,809,046
Sewerpipe			1,102,100
Fireclay, drain tile, pottery, etc			1,169,752
Kaolin	tons.	1,000	10,000
Lime	bush.	6,245,189	1,247,517
Sand and gravel			2,448,738
Sand-lime brick			624,335
Slate	sq.	1,075	4,837
Stone—			
Granite			2,179,930
Limestone			2,730 438
Marble (not complete)			192.533
Sandstone			490,584
Total structural materials and clay products			26,197,734
All other non-metallic			43,407,737
Total value, metallic			58,870,028
Grand total, 1914			128,475,499

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* Tons of 2,000 pounds.

Metal Prices.

—	1909.	1910.	1911.	1912.	1913.	1914.
	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.
Copper, New York	12·982	12·738	12·376	16·341	15·269	13·602
Lead "	4·273	4·446	4·420	4·471	4·370	3·862
" London	2·839	2·807	3·035	3·895	4·072	4·146
" Montreal*	3·268	3·246	3·480	4·467	4·659	4·479
Nickel, New York	30·000	40·000	40·000	40·000	40·000	40·000
Silver "	51·503	53·486	53·304	60·835	59·791	54·811
Spelter "	5·503	5·520	5·758	6·943	5·648	5·213
Tin "	29·725	34·123	42·281	46·096	44·252	34·301

* Quotations furnished by Messrs. Thomas Robertson & Company, Montreal, Que.

SMELTER PRODUCTION.

Statistics of the production of copper, lead, and silver smelters and refineries, showing the tonnage of ore treated, the matte, blister, base bullion, or refined metal produced, have been collected by the Mines Branch since 1908.

The total quantity of ores and concentrates treated in these smelters during 1914 was 2,649,935 tons (including 58,894 tons of imported ore), as compared with 3,037,391 tons in 1913. The largest proportion of the total tonnage, about 61 per cent in 1914, consists of the copper-gold-silver ores of British Columbia, chiefly from the Boundary (Phœnix and Greenwood), Rossland and Coast (Britannia, Texada Island and Granby Bay) districts. The nickel-copper ores of the Sudbury district, Ontario, contributed about 35·7 per cent of the tonnage, the balance being lead ores and other ores treated in lead furnaces and the silver cobalt ores of Ontario treated in silver smelters. Gold and silver ores treated by cyanide processes are not included in this record.

The quantities of the several classes of ores, in tons, smelted during the past seven years have been as follows:—

Year.	Nickel-copper ores.	Silver-cobalt ores.	Lead ores.	Copper-gold silver ores.	Totals.
1908	360,180	7,182	53,545	1,797,488	2,218,395
1909	462,336	8,384	54,539	1,850,889	2,376,148
1910	628,947	9,166	57,549	1,987,752	2,683,714
1911	610,834	9,330	55.408	1,517.981	2,193,553
1912	725,065	8,097	59,932	2,212,316	3,005,410
1913	823,403	6,124	88,100	2,119,754	3,037,391
1914	917,053	5,661	71,064	1,612,197	2,649,935

The products obtained in Canada from the treatment of these ores include: pig lead produced at Kingston, Ont. (furnace idle in 1914); refined pig lead and lead pipe produced at Trail, B.C., and fine gold, fine silver, copper sulphate and antimony produced from the residues of the Trail lead refinery; silver bullion, white arsenic, nickel oxide and cobalt oxide produced in Ontario from the Cobalt district ores. In addition to these refined products, blister copper, copper matte, nickel-copper matte, cobalt material or mixed nickel and cobalt oxides are produced and exported for refining.

The aggregate results of smelting and refining operations may be summarized as shown in the next table. Unfortunately the figures cannot be taken to represent the total production from smelting ores mined in Canada, since considerable quantities of copper and silver ores are still shipped to other smelters outside of Canada for smelting.

Smelter and Refinery Production in Canada.

Smelter products obtained and exported for refining.	1911.	1912.	1913.	1914.
	Tons.	Tons.	Tons.	Tons.
(1) Blister copper	10,710	17,063	15,270	13,238
(2) Copper matte	11,329	6,727	5,159	6,291
(3) Nickel-copper matte	32,607	41,925	47,150	46,396
(4) Cobalt material	630	642	122	101

		1912.		1914.	
		Refined products.	Metals contained in matte, blister, and base bullion.	Refined products.	Metals contained in matte, blister, and base bullion.
Gold	oz.	11,977	213,279	11,088	170,818
Silver	"	13,789,769	934,601	11,096,861	873,400
Lead	lb.	37,923,043		36,443,706	
Copper	"		59,245,722		59,237,016
Copper sulphate	"	130,533		152,069	
Nickel	"		49,676,772		45,517,937
Cobalt oxide	"	660,079		895,789	
Nickel oxide	"	268,301		391,312	
White arsenic	"	3,384,249		3,474,322	

(1) Blister copper carrying gold and silver values.
(2) Copper matte " "
(3) Bessemer nickel-copper carrying small gold and silver values as well as metals of the platinum group.
(4) Cobalt material carrying nickel and silver values.

GOLD.

The total production of gold, in placer and mill bullion and in smelter products in 1914, is estimated at 770,374 fine ounces, valued at $15,925,044, as compared with 802,973 fine ounces valued at $16,598,923 in 1913, showing a decrease of $673,879, or about 4 per cent.

Of the total production in 1914, about $5,695,508 was derived from placer and alluvial mining—$6,050,690 in bullion from milling ores, and $4,228,846 from matte, blister copper and other smelter products, etc. In 1913, of the total production, about $6,346,072 were derived from alluvial workings; $5,185,544 in bullion from milling ores, and $5,067,307 from smelter products derived from ores, concentrates, etc., smelted.

The production in Nova Scotia and Quebec is small compared with the other provinces but shows an increase of over 25 per cent in 1914.

The Ontario production, $5,546,356, shows an increase of over a million dollars due to the extension of milling facilities in the Porcupine field.

No records have been received with respect to gold production in the Beaver Lake district of Saskatchewan or of recoveries from the river bars near Edmonton, Alberta, although activity has been reported in both localities.

The production in British Columbia was $5,177,343, of which $524,000 is credited to placer workings as estimated by the Provincial Mineralogist, and $4,653,343 to smelter products and bullion from milling ores. The British Columbia production in 1913 was $6,149,027, being $510,000 from placer workings, and $5,639,027 from smelter products and mill bullion.

The Yukon production shows a falling off of $721,384, the total in 1914 being $5,125,396 including a small value in mill bullion, as against $5,846,780 in 1913. The total amount on which royalty was paid during the year 1914, according to the records of the Mining Lands and Yukon Branch, Interior Department, was 309,691·17 ounces, as against 352,900·04 ounces in 1913.

The exports of gold bearing dust, nuggets, gold in ore, etc., in 1914, were valued at $15,242,200.

SILVER.

The falling off in price of silver amounting to 4 cents on the average price for the year, the cessation of price quotations, and the difficulties of marketing the metal immediately following the declaration of war restricted operations in the Cobalt camp, causing a lower production than might have been expected under normal conditions.

The total Canadian production in 1914 was 27,544,231 ounces, valued at $15,097,269, as against 31,845,803 ounces valued at $19,040,924 in 1913, a decrease of 4,301,572 ounces or 13·5 per cent in quantity, and of $3,943,655, or 20·7 per cent in total value.

Of the total production 24,215,926 ounces or 88 per cent is credited to Ontario. The production from the silver camps is reported as 9,614,069 fine ounces in bullion shipped, and 14,544,524 ounces (after deducting 5 per cent for smelter losses) contained in ore and concentrates shipped from Cobalt district. There is also included in the total a small quantity of silver contained in gold bullion shipped.

The Ontario production in 1913 was 28,411,261 ounces showing a falling off for the province of 4,003,805 ounces, or about 14·1 per cent.

In addition to the bullion shipments from the Cobalt camp, 9,052,993 ounces were produced in other silver refineries in the province, making a total of 18,667,062 ounces or 67 7 per cent of the Ontario production recovered within the province in the form of bullion.

The production in British Columbia, representing refined silver and silver contained in smelter products and estimated recoveries from ores exported, was in 1914 about 3,212,111 ounces, as compared with 3,312,343 ounces in 1913.

In Quebec province there is a small silver content in the pyrites ores shipped, while in the Yukon 67,432 ounces are estimated as being contained in the placer gold produced and recovered from the copper ores shipped from Whitehorse.

The exports of silver bullion and silver in ore, etc., as reported by the Customs Department, were 28,020,089 ounces valued at $15,584,813. There is also an importation recorded of silver in bars, blocks, etc., valued at $629,279.

The price of silver in New York reached a maximum of 59 cents during the first week of May but fell off to 49 cents during the last two months of the year.

COPPER.

The copper situation in 1914 was marked by an increased production in Ontario and Quebec as against a falling off in British Columbia and the Yukon, leaving the net result as a very slight decrease.

The copper contained in matte, blister copper, etc., produced in Canadian smelters together with the estimated recoveries or amounts paid for in ores exported amounted in 1914 to 75,738,386 pounds, which, at the average New York value of refined copper, would be worth $10,301,935. Compared with the production in 1913, which was 76,976,925 pounds valued at $11,753,606, there was a falling off of only 1,238,539 pounds or 1·6 per cent, but, owing to the lower price, a much larger percentage decrease in total value.

The production in Quebec from pyrites ores was 4,201,497 pounds as compared with 3,455,887 pounds in 1913. The actual copper content of the ores shipped was nearly 50 per cent in excess of these figures, but only about two-thirds of the copper is reported as paid for.

The Ontario production is derived chiefly from the nickel-copper ores of the Sudbury district and of the Alexo mine, although there is a small amount of copper contained in the silver ores shipped from Cobalt, some of which is paid for. There was also a small shipment from the Dane mine on the T. & N. O. railway.

The production in 1914 is reported as 28,948,211 pounds, an increase of 3,062,282 pounds over the 1913 output which was 25,885,929 pounds. The Mond Nickel Company contributed a much larger percentage of the total production during 1914 than in 1913, and, as this company's ores are higher in copper than those being worked by the Canadian Copper Company, we have the, perhaps somewhat unexpected, result of a decrease in nickel production accompanied by an increase in copper production from these Sudbury district ores.

The British Columbia production was 41,221,628 pounds as against 45,791,579 pounds in 1913, a falling off of 4,569,951 pounds. The Greenwood smelter closed down in August and the Grand Forks smelter restricted its operations very severely on the outbreak of war, but started up several furnaces again before the close of the year. The blowing in of the smelter at Anyox, treating the Hidden Creek and other coast ores, and the continuance of large shipments from the Britannia mine made the coast production slightly greater than that of the southern interior smelters and, with an increased production at Trail, almost compensated for the falling off in the Boundary district.

The Pueblo mine was again the principal copper producer in the Yukon with an output only slightly less than that in 1913.

The New York price of electrolytic copper fell off from 14·7 cents in February to 12·7 cents during the last week of July. Quotations ceased on the declaration of war, but were resumed in November at a little over 11 cents, increasing to 13·2 cents in December. The average monthly price for the year was 13·602 cents, as against 15·269 cents in 1913, and was, with the exceptions of 1912 and 1913, the highest average since 1907.

There was a large falling off in the imports of copper of all kinds in 1914. The total imports were valued at $4,256,901, and included crude and manufactured copper, 28,280,812 pounds valued at $3,983,322, copper sulphate, 1,143,039 pounds valued at $53,802, and other manufactures of copper valued at $219,777. The total imports in 1913 were valued at $7,415,008, and included crude and manufactured copper, 41,011,961 pounds valued at $6,935,822, copper sulphate 2,037,714 pounds valued at $107,960, and other manufactures valued at $371,226.

The exports of copper were: Copper fine in ore, matte, etc., 68,830,059 pounds, valued at $7,130,778, and copper black or coarse, etc., 6,581,564 pounds valued at $908,201, a total of 75,411,623 pounds valued at $8,038,979.

LEAD.

The smelter production of lead from Canadian ores in 1914 was 36,337,765 pounds which, valued at 4·479 cents per pound, the average price of pig lead in

Montreal for the year, would be worth $1,627,568. The production in 1913 was 37,662,703 pounds, valued at $1,754,705. With the exception of a small tonnage from the Yukon, the 1914 production was entirely from British Columbia ores, and was almost all recovered at the Trail smelter.

The exports of lead in ore, etc., in 1914 are reported as 246,100 pounds valued at $2,681, and of pig lead 510,573 pounds valued at $19,507.

The total value of the imports of lead and lead products in 1914 was $1,042,538, and included old scrap and pig lead, 15,444,100 pounds valued at $590,557, manufactured lead 3,394,930 pounds valued at $186,165, manufactures n.o.p., $99,285, and litharge and lead pigments $166,531. The imports of litharge and pigment would contain approximately 1,449 tons of metallic lead and the total imports of metallic lead would therefore exceed 10,869 tons.

The average monthly price of lead in Montreal during 1914 was 4·479 cents as against 4·659 cents in 1913. This is the producer's price for lead in car lots as per quotations kindly furnished by Messrs. Thos. Robertson & Co.

The average monthly price of lead in New York was 3·862 cents, and in London £19·079 per gross ton, equivalent to 4·146 cents per pound.

NICKEL.

The declaration of war resulted in the almost immediate closing down of a considerable portion of the mining and smelting operations of the Canadian Copper Company in the Sudbury district, and although they were partially resumed before the close of the year the Company's output was greatly reduced. The Mond Nickel Company on the other hand, having increased the capacity of its smelter at Coniston, nearly doubled its output. Ores from the Alexo nickel mine north of Cobalt were also reduced in this smelter. Ten separate properties were worked by these Companies.

The nickel-copper ore is reduced in smelters and converters to a Bessemer matte containing from 77 to 82 per cent of the combined metals and shipped in that form to Great Britain and the United States for refining; the product of the Canadian Copper Company going to New Jersey and that of the Mond Nickel Company to Wales. A portion of the matte produced by the Canadian Copper Company is used for the direct production of Monel metal, an alloy of nickel and copper, without the intermediate refining of either metal.

The total production of matte in 1914 was 46,396 tons valued by the producers at the smelters at $7,189,031, and containing 28,895,825 pounds of copper and 45,517,937 pounds of nickel. The tonnage of ore smelted (part being previously roasted) was 947,053. The production in 1913 was 47,150 tons of matte, containing 25,875,546 pounds of copper and 49,676,772 pounds of nickel, showing an increase in 1914 in copper content and a falling off in nickel.

There is also a small recovery of nickel in the form of nickel oxide from the Cobalt district ores, the production in 1914 being reported as 391,312 pounds of oxide valued at $26,483.

The aggregate results of the smelting operations on nickel-copper ores during the past five years and the exports of nickel are shown in tabular form, while a record taken from the "Foreign Commerce of the United States" has been added showing the imports of nickel into, and exports from that country. The values of the United States exports, which are not quoted in the tables, range from 31 to 39 cents per pound and averaged about 34 cents in 1914.

It will be noted that a much larger quantity of nickel finds its way to the United Kingdom through United States refineries than is exported directly from Canada.

Exports of nickel from New Caledonia for the first seven months of 1914 are reported as 52,498 metric tons of ore and 2,275 tons matte, of which the total nickel content would probably not exceed 8,000,000 pounds.

The price of refined nickel in New York remained fairly constant throughout the year, quotations published by the Engineering and Mining Journal, 40 to 45 cents per pound for nickel shot, blocks or plaquettes; electrolytic 5 cents higher per pound.

Production of Nickel in Canada.	1911. Tons of 2,000 lb.	1912. Tons of 2,000 lb.	1913. Tons of 2,000 lb.	1914. Tons of 2,000 lb.
Ore mined	612,511	737,584	784,697	1,000,364
Ore smelted	610,834	725,065	823,403	947,053
Bessemer matte produced	32,607	41,925	47,150	46,396
Copper content of matte	8,966	11,116	12,938	14,448
Nickel " "	17,049	22,421	24,838	22,759
Spot value of matte	$ 4,945,592	$ 6,305,102	$ 7,076,945	$ 7,189,031

Exports of Nickel from Canada.	Lb.	Lb.	Lb.	Lb.
Nickel contained in matte, etc.—				
Exported to Great Britain	5,023,393	5,072,867	5,164,512	10,291,979
Exported to United States	27,596,578	39,148,993	44,224,119	36,015,642
Exported to other countries	....	....	70,386	220,706
	32,619,971	44,221,860	49,459,017	46,538,327

Imports of Nickel into United States.	1911.	1912.	1913.	1914.
Gross tons of ore and matte........ tons.	23,993	33,101	37,623	29,564
Nickel contents........ lb.	29,545,967	42,168,769	47,194,101	35,006,700
Exports of Nickel from United States—				
To France........ lb.	5,463,358	5,083,947	3,631,858	3,457,157
To Netherlands........ "	9,101,150	7,387,447	6,622,811	835,168
To United Kingdom........ "	7,196,259	8,191,364	8,221,640	10,856,369
To other countries........ "	3,338,819	5,152,258	10,096,779	12,446,458
Total........ "	25,099,586	25,815,016	29,174,088	27,595,152

IRON ORE.

The iron ore shipments from mines in Canada during 1914 are reported as 244,854 short tons valued at $542,041. These shipments included 199,292 tons of hematite and roasted siderite, and 45,562 tons of magnetite and concentrates.

The total shipments of ore in 1913 were 307,634 tons, including 92,386 tons of hematite and roasted siderite, 209,886 tons of magnetite and concentrates and 5,362 tons of titaniferous ore.

Exports of iron ore from Canada during 1914 were recorded by the Customs Department as 135,451 tons valued at $360,974.

According to mine operators' reports, however, 184,444 tons were shipped to Canadian smelters, and 60,410 tons were exported to the United States. The imports into the United States from Canada are also reported by the Washington Trade Statistics as 58,816 tons, valued at $153,415.

Imports of iron ore in 1914 were, according to Customs records, 1,147,168 tons, valued at $2 387,358.

Shipments of iron ore from the Wabana mines, Newfoundland, in 1914, by the two Canadian companies operating there were 639,430 short tons, of which 422,920 tons were shipped to Sydney, Cape Breton, and 216,510 tons to the United States and Europe. In 1913 the shipments were 1,605,920 short tons, of which 1,048,432 tons were shipped to Sydney, and 557,488 tons to the United States and Europe.

PIG-IRON.

The total production of pig-iron in Canadian blast furnaces in 1914 was 783,164 tons of 2,000 pounds, valued at approximately $10,002,856, as compared with 1,128,967 tons, valued at $16,540,012 in 1913. A large portion of this production is used directly in the manufacture of steel and the values are in part estimated. The output shows a falling off of 345,803 tons or 30·6 per cent, and is the smallest since 1909.

Of the total production in 1914, 9,380 tons were made with charcoal and 773,784 tons with coke. The classification of the production, according to the purpose for which it was intended, was as follows: Bessemer 230,817, basic 346,553, foundry and malleable 205,794.

The ore charged to blast furnaces included 182,964 tons of Canadian ore and 1,324,326 tons of imported ore, and 33,583 tons of mill cinder, etc. The amount of coke used during the year was 921,171 tons, comprising 330,269 tons from Canadian coal, and 590,902 tons of imported coke or coke made from imported coal. The quantity of charcoal fuel used was 920,045 bushels, and of limestone flux 447,638 tons.

The number of men employed at blast furnaces was 1,018, and total wages paid $693,632.

The furnace plants operated for varying periods of time, included those of the Dominion Iron and Steel Co., and the Nova Scotia Steel and Coal Co., at Sydney, and North Sydney; the Algoma Steel Co., at Sault Ste. Marie; the Steel Co. of Canada, at Hamilton; the Standard Iron Co., at Deseronto; and the Canadian Iron Furnace Co., at Port Colborne. All other furnaces were idle throughout the year.

The production of pig-iron by provinces in 1913 and 1914 was as follows:—

—	1913.			1914.		
	Tons.	Value.	Value per ton.	Tons.	Value.	Value per ton.
		$	$ cts.		$	$ cts.
Nova Scotia	480,068	7,201,020	15 00	227,052	2,951,676	13 00
Ontario	648,899	9,338,992	14 39	556,112	7,051,180	12 68
	1,128,967	16,540,612	14 65	783,164	10,002,856	12 77

There was also a production during 1914 in electric furnaces of 7,524 tons of ferro alloys (ferro-silicon and ferro-phosphorus) valued at $478,354, compared with 8,075 tons valued at $193,018 in 1913. This production is chiefly 50 per cent ferro-silicon.

The exports of pig-iron and ferro-silicon, etc., during the year are reported as 19,063 tons, valued at $486,366. The imports were: pig-iron, 78,591 tons, valued at $981,107; charcoal pig 86 tons, valued at $1,082; ferro-manganese and ferro-silicon 22,147 tons, valued at $549,485; or a total of 100,827 tons, valued at $1,531,674.

COAL AND COKE.

The total production of marketable coal for the year 1914 comprising sales and shipments, colliery consumption and coal used in making coke or otherwise used by the colliery operators, was 13,594,984 short tons, valued at $33,433,108, as against 15,012,178 tons, valued at $37,334,940 in 1913, showing a decrease of 1,417,194 tons, or 9·4 per cent in quantity and of $3,901,832, or 10·4 per cent in total value.

In estimating the values of the coals, arbitrary values are assumed for Nova Scotia and for British Columbia, viz: $2.50 per long ton for the former and $3.50 per long ton for the latter. The value of the coal production in the other provinces is that returned by the operators. The production in Nova Scotia was 7,338,790 tons, a falling off of 641,283 tons, or 8·0 per cent. The Alberta production as kindly furnished by Mr. John Stirling, Inspector of Mines, Alberta, was 3,667,816 tons, a decrease of 346,939 tons or 8·6 per cent, while the British Columbia production was 2,238,339 tons a decrease of 476,081 tons or 21 2 per cent. Saskatchewan with a production of 232,541 tons shows an increase of 19,644 tons or 9·2 per cent, while New Brunswick reports a production of 104,055 tons, an increase of 33,744 tons or 48 per cent. The production of the Yukon is reported as 13,443 tons, a decrease of 6,279 tons or 32 per cent from 1913.

Province.	1912.		1913.		1914.	
	Tons.	Value.	Tons.	Value.	Tons.	Value.
Nova Scotia	7,783,888	$ 17,374,750	7,980,073	$ 17,812,663	7,338,796	$ 16,381,228
British Columbia	3,208,997	10,028,116	2,714,420	8,482,562	2,238,339	6,994,810
Alberta	3,240,577	8,113,525	4,014,755	10,418,941	*3,667,816	9,367,602
Saskatchewan	225,342	368,135	212,897	358,192	232,541	375,438
New Brunswick	44,780	89,560	70,311	166,637	104,055	260,270
Yukon	9,245	44,958	19,722	56,945	13,443	53,760
Total	14,512,829	36,019,044	15,012,178	37,334,940	13,594,984	33,433,108

*Statistics furnished by Mr. John Stirling, Inspector of Mines, Alberta.

The exports of coal in 1914 were 1,423,126 tons, valued at $3,880,175, as compared with exports of 1,562,020 tons valued at $3,961,351 in 1913, a falling off of 138,894 tons or 8 89 per cent.

Imports of coal during the year included bituminous, round and run of mine 7,776,415 tons, valued at $14,954,321, or an average of $1.92 per ton; bituminous slack 2,509,632 tons valued at $3,605,253 or an average of $1.43 per ton; and anthracite 4,435,010 tons valued at $21,241,924 or an average of $4.79 per ton or a total of 14,721,057 tons, valued at $39,801,498. The imports in 1913 were bituminous, round and run of mine 10,743,473 tons valued at $21,756,658; bituminous slack 2,816,123 tons, valued at $4,157,622; and anthracite 4,642,057 tons valued at $22,034,839; or a total of 18,201,953 tons valued at $47,949,119.

There was therefore a decrease in imports of bituminous run of mine of 2,967,058 tons or 27·6 per cent, a decrease in the imports of bituminous slack of 306,791 tons or 10·9 per cent and a decrease in the imports of anthracite of 207,047 tons or 4 5 per cent, or a total decrease in coal imports of 3,480,896 tons or 19·1 per cent.

The apparent consumption of coal during the year was 26,809,778 tons as against a consumption of 31,582,545 tons in 1913. Of the consumption in 1914 about 45·4 per cent was from Canadian mines and 54·6 per cent imported.

Coke.—The total output of oven coke during 1914 was 1,015,253 tons of 2,000 lb. made from 1,533,365 tons of coal, of which 1,030,053 tons were mined in Canada, and 503,312 tons were imported. The total quantity of coke sold, or used by the producers during the year was 1,019,082 tons valued at $3,634,511.

In 1913 the total output was 1,517,133 tons and the quantity sold or used by the producers 1,530,499 tons valued at $5,919,596.

The output by provinces in 1914 was: Nova Scotia, 345,880 tons; Ontario, 377,514 tons; Alberta, 28,541 tons, and British Columbia, 263,318 tons. The production from Ontario was entirely from imported coal.

By-products from coke ovens during the year included 8,572 tons of ammonia sulphate, 5,714,172 gallons of tar, and 3,201,097 thousand feet of gas.

The only coke ovens operated during the year were those at Sydney, Sydney Mines and Westville, Nova Scotia; Sault Ste. Marie, Ontario; Coleman, Alberta; and Fernie, Michel, and Hosmer, British Columbia. At the end of the year there were 797 ovens in operation and 2,297 idle.

Asbestos.

The asbestos production in 1914 was obtained from the districts of Black Lake, Thetford, Robertsonville, and Danville, in the province of Quebec. Both output and sales show a considerable falling off, while there is an increase in the stocks on hand at the close of the year, a result which is no doubt due largely, if not entirely, to the war.

The total output in 1914 was 107,668 tons, as against 132,564 tons in 1913, a falling off of 24,896 tons, or 18·7 per cent. Notwithstanding this decrease the output was greater than that of any other preceding year. The sales and shipments of asbestos during 1914 were 96,542 tons, valued at $2,892,266, or an average of $29.96 per ton, as against sales in 1913 of 136,951 tons valued at $3,830,909, or an average of $27.97 per ton. The 1914 sales were exceeded during each of the previous three years. Stocks on hand at December 31, 1914, were 31,171 tons, as compared with stocks of 20,787 tons at the end of the previous year.

The number of men employed in mines or quarries and mills, was 2,992 and amount paid in wages, $1,283,977, as against 2,951 men employed, and $1,687,957 paid in wages in 1913.

The total quantity of asbestos rock milled during the year is reported as 1,717,629 tons which, with a mill production of 103,607 tons, shows an average estimated content of about 6·03 per cent of fibre in the rock.

The output and sales of crude and mill stock separately is shown for 1913 and 1914 in the following tables. The classification is based on valuation: Crude No. 1, comprising material valued at $200 per ton and upwards, and Crude No. 2, under $200; mill stock No. 1 includes mill fibre valued at from $30 upwards, No. 2 from $15 to $30, and No. 3 under $15.

The total sales of crude asbestos in 1914 were 4,147·5 tons, valued at $773,193, or an average of $186.42 as against sales in 1913 of 5,660·3 tons, valued at $989,162, or an average of $174.45 per ton, showing a lower tonnage but a higher average value in 1914.

The total sales of mill stock in 1914 were 92,394 tons, valued at $2,119,073, or an average of $22.94 per ton, against 131,291 tons in 1913, valued at $2,841,747, or an average of $21.64 per ton, again a smaller tonnage but a higher average price than in the previous year.

Exports of asbestos during the twelve months ending December 31, 1914, were 81,081 tons, valued at $2,298,646, as against 103,812 tons, valued at $2,848,047 exported in 1913. There was also an export classed as asbestos sand in 1914, amounting to 18,991 tons, valued at $108,548 tons, or an average value per ton of $5 71.

Output Sales and Stocks in 1914.

	Output.	Sales.			Stock on hand. Dec. 31.		
	Tons.	Tons.	Value.	Per ton.	Tons.	Value.	Per ton.
			$	$		$	$
Crude No. 1	1,450·55	1,335 9	402,417	301 23	984·3	301,237	306 04
" 2	2,610·4	2,811·65	370,776	131 87	1,410·9	187,338	132 78
Mill stock No. 1	16,141	19,388	932,893	48 12	4,616	229,361	49 69
" 2	58,362	47,851	963,973	20 15	15,114	305,809	20 23
" 3	29,101	25,155	222,207	8 83	9,046	76,522	8 46
Asbestos	107,607 95	96,541·55	2,892,266	29 96	31.171·2	1,100,267	35 30
Asbestic	....	21,031	17,540	0·83	....	....	......

Output Sales and Stocks in 1913

	Output.	Sales.			Stock on hand. Dec. 31.		
	Tons.	Tons.	Value.	Per ton.	Tons.	Value.	Per ton.
			$	$ cts.		$	$ cts.
Crude No. 1	2,015·4	1,853·3	531,200	286 62	880·5	247,877	281 52
" 2	3,010	3,807	457.962	120 29	1,522	178,789	117 47
Mill stock No. 1	23,441	26,198	1,229,908	46 95	6,755	350,165	51 84
" 2	58,592	60,164	1,201,215	19 97	4,809	108,285	22 52
" 3	45,503	44,929	410,624	9 14	6,820	54,604	8 01
Asbestos	132,564·4	136,951·3	3,830,909	27 97	20,786·5	939·720	45 21
Asbestic	....	24,135	19,016	0 79	....	....	....

PETROLEUM AND NATURAL GAS.

Although crude oil has been struck in several of the prospect wells being sunk in Alberta, and a few thousand gallons obtained from the Dingman Well, No. 1, of the Calgary Petroleum Products, Ltd., were sold, the western fields have not, as yet, reached the stage of commercial production, and the Canadian output is still practically confined to the old established fields in Ontario supplemented by a few barrels pumped from gas wells in New Brunswick.

The annual output, which has been steadily declining during the past seven years, shows a further falling off in 1914. The average price received for crude oil was also lower than in the previous year.

A bounty of one and a half cents per imperial gallon is paid upon the production of crude petroleum, the Petroleum Bounty Act being administered and payments made by the Department of Trade and Commerce.

According to the records of this Department, the total output of petroleum in Ontario and New Brunswick during 1914 was 214,418 barrels, or 7,504,619 gallons, on which a bounty of $340,924 was paid. The average monthly price per barrel at Petrolia was $1.59, as compared with $1·782 in 1913. During the first three months of 1914, $1.89 per barrel was quoted, but the price decreased to a minimum of $1.33 during the past three months of the year.

In addition to the above, 13,549 gallons, or 387 barrels, valued at $2,200, were reported as having been sold from the Dingman Well in Alberta upon which no bounty was claimed. The total Canadian production is therefore stated as 7,518,168 gallons, or 214,805 barrels, valued at $343,124.

The production in 1913 was 7,982,798 gallons, or 228,080 barrels, valued at $406,439. The production in Ontario during 1914 included in the above total was 212,693 barrels. The production by districts in this province, as furnished by the Supervisor of Petroleum Bounties, at Petrolia, was as follows, in barrels: Lambton, 154,186; Tilbury, 18,530; Bothwell, 33,961; Dutton, 2,190; Onondaga, 2,437, and Belle River, 1,191, or a total of 212,495 barrels. In 1913 the production by districts was: Lambton, 155,747; Tilbury, 26,824; Bothwell, 34,349; Dutton, 4,610; Onondaga, 4,172, and Belle River, 464, or a total of 226,166 barrels.

The production in New Brunswick in 1914 was 1,725 barrels, as against 2,111 barrels in 1913, and 2,679 barrels in 1912.

Exports of petroleum entered as crude mineral oil in 1914 were 3,996 gallons valued at $362, and of refined oil 3,922 gallons valued at $826. There was also an export of naphtha and gasoline of 43,023 gallons valued at $11,607.

The total value of the imports of petroleum and petroleum products in 1914 was $11.174,765, as against a value of $13,348,326 in 1913.

The total imports of petroleum oils, crude and refined, in 1914 were 244,487,973 gallons, valued at $11,072,362, in addition to 1,594,236 pounds of wax and candles valued at $102,401. The oil imports included: crude oil, 195,207,210 gallons, valued at $5,750,971; refined and illuminating oils, 12,833,065 gallons, valued at $970,481; gasoline, 24,396,401 gallons, valued at $2,747,360; lubricating oils, 5,767,676 gallons, valued at $940,143, and other petroleum products, 6,282,621 gallons valued at $663,407.

The total imports in 1913 were 222,779,028 gallons of petroleum oils crude and refined, valued at $13,238,429, in addition to 1,628,837 pounds of paraffin wax and candles, valued at $109,897. The oil imports included: crude oil, 162,061,926 gallons, valued at $5,250,835; refined and illuminating oils, 19,393,627 gallons, valued at $1,394,440; gasoline, 29,525,180 gallons, valued at $4,822,941; lubricating oils, 6,789,451 gallons, valued at $1,172,986, and other petroleum products, 5,008,844 gallons, valued at $597,227.

There was thus in 1914 an increased importation of crude oils and a decrease in imports of refined illuminating oils, lubricating oils and gasoline.

NATURAL GAS.

The total production in 1914 was approximately 21,047 million feet, valued at $3,511,302, of which 426 million feet valued at $54,249 was produced in New Brunswick, 13,675 million feet valued at $2,206,733 in Ontario, and 6,946 million feet valued at $1,250,320 in Alberta.

The production in 1913 was 20,478 million cubic feet, valued at $3,307,381, of which 829 million feet valued at $174,147 was produced in New Brunswick, 12,475 million feet valued at $2,055,768 in Ontario, and 7,174 million feet valued at $1,079,466 in Alberta.

These values represent as closely as can be ascertained the value received by the owners or operators of the wells for gas produced and sold or used. The values do not represent what consumers have to pay, since, in cases where transmission is by separately operated pipe line companies, such cost is not included.

CEMENT.

The year 1914 has witnessed a very large falling off in the production of nearly all materials of construction. This situation while possibly aggravated by the war was due primarily to conditions which had already begun to show their effects during the latter part of 1913.

The total quantity of Portland cement, including slag cement and natural Portland, made in 1914 was 8,727,269 barrels of 350 net pounds each as compared with 8,886,333 barrels made in 1913, a decrease of 159,064 barrels, or about 2 per cent.

The total quantity of Canadian-Portland cement sold or used during 1914 was 7,172,480 barrels, valued at $9,187,924, or an average of $1.28 per barrel, as compared with 8,658,805 barrels valued at $11,019,418 or an average of $1.27 per barrel in 1913, showing a decrease of 1,486,325 barrels, or 17 per cent.

The total imports of cement in 1914 were 343,076 cwt., equivalent to 98,022 barrels of 350 pounds, valued at $147,158, or an average of $1.50 per barrel, as compared with imports of 254,093 barrels valued at $409,303, or an average of $1.61 in 1913.

The total consumption of cement therefore, neglecting a small export, was 7,270,502 barrels, as compared with a consumption of 8,912,898 barrels in 1913; a decrease of 1,642,396 barrels, or 18·4 per cent.

Detailed statistics of production during each of the past four years are shown as follows:—

——	1911.	1912.	1913.	1914.
	Bl.	Bl.	Bl.	Bl.
Portland Cement sold	5,692,915	7,132,732	8,658,805	7,172,480
Portland Cement manufactured	5,677,539	7,141,404	8,886,333	* 8,727,269
Stock on hand Jan. 1st	918,965	894,822	862,067	* 1,074,610
Stock on hand Dec. 31st	903,589	903,091	1,089,595	* 2,629,399
Value of cement sold	$ 7,644,537	$ 9,106,556	$11,019,418	$ 9,187,924
Wages paid	2,103,838	2,623,902	3,466,451	2,271,006
Men employed	3,010	3,461	4,276	2,977

* Partially estimated.

The average price per barrel at the works in 1914 was $1.28 as compared with $1.27 in 1913, $1.28 in 1912, and $1.34 during 1911 and 1910.

The imports of cement in 1914 included 26,774 barrels valued at $35,517 from Great Britain, 69,117 barrels valued at $108,487 from the United States, and 2,131 barrels valued at $3,154 from other countries.

The consumption of Portland cement during each of the past five years was as follows:—

Annual Consumption of Portland Cement.

Calendar Year.	Canadian.		Imported.		Total
	Barrels.	Per cent.	Barrels.	Per cent.	Barrels.
1910	4,753,975	93	349,310	7	5,103,285
1911	5,692,915	90	661,946	10	6,354,831
1912	7,132,732	83·3	1,434,413	16·7	8,567,145
1913	8,658,805	97·1	254,093	2·9	8,912,988
1914	7,172,480	98·7	98,022	1·3	7,270,502

Exports of Products of the Mine and Manufactures of Mine Products, Calendar Year, 1914.

(Compiled from Trade and Navigation Monthly Statements.)

Products.		Quantity.	Value.
			$
Arsenic	cwt.	37,519	132.567
Asbestos	tons.	81,081	2,298,646
Asbestos sand	"	18,991	108,548
Coal	"	1,423,126	3,880,175
Feldspar	"	18,072	74,100
Gold	$	....	15,242,200
Gypsum	tons.	345,830	404,234
Copper, fine, in ore, etc	lb.	68,830,059	7,130,778
" black or coarse and in pigs	"	6,581,564	908,201
Lead, in ore, etc	"	246,100	2,681
" pig, etc	"	510,573	19,507
Nickel, in ore, etc	"	46,528,327	5,149,427
Platinum	oz.	43	2,161
Silver	"	28,020,069	15,584,813
Mica	lb.	669,163	178,940
Mineral pigments	cwt.	35,549	22.311
Mineral water	gal.	2,287	599
Oil, mineral, crude, etc	"	3,996	362
Oil, refined	"	3,922	826
Ores—			
Antimony	tons.	....	....
Corundum	"	947	87,740
Iron	"	135,451	360,974
Manganese	"	30	750
Other ores	"	12,770	782,437
Phosphate	"	247	677
Plumbago	cwt.	18,375	50,528
Pyrites	tons.	89,999	377,985
Salt	cwt.	9,527	5,229
Sand and gravel	tons	952,370	802,358
Stone, ornamental	"	231	5,607
" building	"	63,009	46,198
" crushed	"	25,130	18,153
" for manufacture of grindstones	"	51	294
Other products of the mine		....	101,096
Total mine products		....	53,781,102
MANUFACTURES.			
Agricultural Implements—			
Mowing machines	No.	21,457	725,831
Cultivators	"	6,030	146.668
Reapers	"	3,919	223,228
Drills	"	3,961	259.701
Harvesters and binders	"	19,474	2,015,996
Ploughs	"	12,896	324,349
Harrows	"	6,252	92,556
Hay rakes	"	6.524	196,519
Seeders	"	32	1,810
Threshing machines	"	1,965	799,307
All other	$	....	290,520
Parts of	"	....	712,414
Asbestos, manufactures of	"	....	94,538
Bricks	M	1,486	11.871
Cement	$	....	2,223
Clay, manufactures of	"	....	26,866
Coke	tons	67,838	306,117
Drugs—			
Acetate of lime	lb.	16,052,255	282,146
Acid sulphuric	"	7,485,509	45,612
Calcium carbide	"	15,447,014	470,387
Phosphorus	"	610,350	92,303

Exports of Products of the Mine and Manufactures of Mine Products, Calendar Year, 1914—*Concluded.*

(Compiled from Trade and Navigation Monthly Statements.)

Products.		Quantity.	Value.
MANUFACTURES—*Concluded.*			$
Earthenware and all manufactures of	$		9,536
Fertilizers	"		2,390,194
Grindstones, manufactured	"		24,113
Gypsum and plaster ground	"		35,490
Iron and Steel and manufactures of—			
Stoves	No.	4,198	25,149
Gas buoys and parts of	$		21,609
Castings, n.o.p	"		24,218
Pig-iron	tons.	11,198	201,145
Ferro-Silicon and Ferro-Compounds	"	4,865	285,221
Wire and wire nails	cwt.	193,255	355,781
Linotype machines and parts of	$		5,562
Machinery, n.o.p.	"		344,689
Sewing machines	No.	2,105	31,392
Washing machines	$		33,986
Typewriters	No.	3,055	200,441
Scrap iron and steel	cwt.	708,107	446,337
Hardware, viz.: tools, etc	$		95,497
" n.op.	"		190,763
All other, n.o.p.	"		2,931,968
Lime	"		16,927
Metals—			
Aluminium, in bars, etc	cwt.	145,108	2,364,907
" manufactures of	$		5,571
Brass, old and scrap	cwt.	21,209	196,710
Copper, old and scrap	"	49,871	231,710
Metallic shingles, etc	$		105,663
Metals, n.o.p.	"		393,829
Mineral and aerated water (in bottles)	"		1,768
Oil, gasoline and naphtha	gal.	43,023	11,607
" n.o.p.	"	455,867	104,179
Plumbago, manufactures of	$		72,718
Stone, ornamental	"		1,752
" building	"		370
Tar	"		36,719
Tin, manufactures of	"		24,531
Vehicles—			
Automobiles	No.	5,621	3,011,327
" parts	$		384,428
Bicycles	No.	111	10 021
" parts	$		3,973
Total manufactures			21,752,203
Grand total			75,533,305

APPENDIX

(*Reprint.*)

4-5 GEORGE V.

CHAP. 31.

An Act to regulate the Manufacture, Testing, Storage and Importation of Explosives.

[*Assented to 12th June, 1914.*]

HIS Majesty, by and with the advice and consent of the Senate and House of Commons of Canada, enacts as follows:—

SHORT TITLE.

1. This Act may be cited as *The Explosives Act*. Short title.

INTERPRETATION.

2. In this Act, unless the context otherwise requires,— Definitions.

(*a*) "Department" means the Department of Mines; "Department."

(*b*) "Minister" means the Minister or Acting Minister of Mines; or such Minister as the Governor in Council may designate to administer this Act; "Minister."

(*c*) "authorized explosive" means any explosive the manufacture or importation of which has been authorized under this Act; "Authorized explosive."

(*d*) "explosive" means gunpowder, blasting powder, nitroglycerine, gun cotton, dynamite, blasting gelatine, gelignite, fulminates of mercury, or other metals, coloured fires, and every other substance whether chemical compound or mechanical mixture, used or manufactured with a view to produce a violent effect by explosion, or a pyrotechnic effect, and includes fire works, fuses, rockets, percussion caps, detonators, cartridges, ammunition of all descriptions, fog and other signals, and every other adaption or preparation of an explosive as above defined; "Explosive."

"Factory." (*e*) "factory" means and includes any building, structure or premises in which the manufacture, or any part of the process of manufacture of an explosive, is carried on, and any building or place where any ingredient of an explosive is stored during the process of manufacture;

"Inspector." (*f*) "inspector" means and includes the chief inspector of explosives, an inspector of explosives, a deputy inspector of explosives, and any other person who is directed by the Minister to inspect an explosive or explosive factory or magazine, or to hold an inquiry in connection with any accident caused by an explosive;

"Magazine." (*g*) "magazine" means and includes any building, storehouse, structure or place in which any explosive is kept or stored, other than at or in and for the use of a mine or quarry in a province in which provision is made by the law of such province for the efficient inspection of mines and quarries and explosives used in connection therewith; but does not include the place in which an authorized explosive is kept for the purposes of conveyance when the same is being conveyed or kept in accordance with the provisions of this Act, nor the structure or place in which is kept for private use, and not for sale, an authorized explosive to an amount not exceeding that allowed by regulation under this Act, nor any store or warehouse containing authorized explosives to an amount not exceeding that allowed by regulation under this Act or authorized by any provincial or local authority;

"Operator." (*h*) "operator" means any person who operates a factory for manufacturing explosives, or is the manager of or in charge of such factory, or who is the occupant of or uses a magazine for the storage of explosives;

"Regulations." (*i*) "regulations" means any regulations made by the Governor in Council under the authority of this Act;

"Safety cartridges." (*j*) "safety cartridges" means cartridges for guns, rifles, pistols, revolvers and other small arms, of which the case can be extracted from the small arm after firing, and which are so closed as to prevent any explosion in one cartridge being communicated to other cartridges.

Departments exempted. **3.** This Act shall not apply to the Department of Militia and Defence or the Department of the Naval Service.

IMPORTATION, MANUFACTURE AND USE.

Explosives prohibited unless authorized **4.** Except as herein provided, no person shall have in his possession, or import, store, use or manufacture, whether wholly or in part, or sell, any explosive unless such explosive has been declared by the Minister to be an authorized explosive.

Small quantities excepted.

5. Nothing in this Act shall apply to the making of a small quantity of explosive for the purpose of chemical experiment, and not for practical use or sale.

Certain process prohibited.

6. Except in so far as may be permitted by regulations made under this Act, no person, except in licensed manufacturing factories, shall carry on any of the following processes, namely:—of dividing into its component parts, or otherwise breaking up or unmaking, any explosive; of making fit for use any damaged explosive; or of remaking, altering or repairing any explosive: Provided that this section shall not apply to the process of thawing explosives containing nitro-glycerine, if a proper apparatus or thawing-house is used in accordance with regulations made under this Act or any Provincial law.

LICENSES AND PERMITS.

Licenses.

7. The Minister may issue licenses for factories and magazines, and no one shall manufacture, either wholly or in part, or store explosives except in licensed factories and magazines.

Blending of explosives.

2. Notwithstanding any provisions contained in this Act the Governor in Council, upon the recommendation of the Minister, based upon the report in writing of the deputy minister, accompanied by certificates from the chief inspector and chief chemist of explosives approving of the nature of the components and of the final explosive product, may allow the inexplosive component parts of an authorized explosive from licensed factories and magazines to be assembled and blended at or near the point of use, and such place of blending shall not be deemed a factory or magazine within the meaning of this Act.

Permits for importation.

8. The Minister may issue permits for the importation of authorized explosives, and no one shall import any explosive into Canada, other than safety cartridges, without such permit: Provided, however, that nothing in this section shall prevent any explosive from being transported through Canada by railway in bond, if such transportation is made in a manner authorized by the *Railway Act* or any regulation or order made thereunder.

Transport in bond.

Special permits.

9. The Minister may, on application, and on payment of the prescribed fees, issue a special permit to import, for the purpose of chemical analysis or scientific research, an amount not exceeding two pounds of any explosive specified in such permit.

10.

Application for license.

10. Applications for factory or magazine licenses shall be made in such form and manner as are prescribed by regulation, and the application shall be accompanied by,—

Plan of factory and premises.

(*a*) a plan, drawn to scale, of the proposed factory or magazine and of the land on which such factory or magazine is situated, and also of the lands adjacent thereto on which buildings are erected, with the uses to which such lands and buildings are now put. Such plan to have the exact distances between the several buildings marked thereon;

Description.

(*b*) a description of the situation, character and construction of all buildings and works connected with the factory or magazine, and the maximum amount of explosive to be kept in each building;

Statement of employees.

(*c*) a statement of the maximum number of persons to be employed in each building in the factory or magazine;

Required information.

(*d*) any information or evidence which the Minister may require;

Statement of maximum amount and ingredients.

(*e*) in the case of an application for a factory license, a statement of the maximum amount of explosive, and of ingredients thereof wholly or partially mixed, to be allowed at any one time in any building, machine, or process of the manufacture, or within the distance from such buildings or machine which is limited by regulation;

Statement of processes and position of explosives.

(*f*) . statement of the nature of the processes to be carried on in the factory and in each part thereof, and the place at which each process of the manufacture, and each description of work connected with the factory is to be carried on, and the places in the factory at which explosives and anything liable to spontaneous ignition, or inflammable or otherwise dangerous, are to be kept.

Permits for experiments, and testing new explosives.

11. The Minister may, on application and on payment of such fees as are prescribed by regulation, issue a permit to manufacture for experimental or testing purposes only, and not for sale, any new explosive, upon such conditions and subject to such restrictions as are fixed by the Minister.

Permit for alteration or addition to factory.

12. The owner or operator of a factory or magazine shall not make any material alteration or addition to a licensed factory or magazine, or rebuild any part thereof, until he has obtained a permit from the Minister; and before such permit may be granted he shall submit such plans and other information and evidence as the Minister may require.

Change of owner or occupier.

13. A factory or magazine license shall not be affected by any change in the persons who own or operate the factory or magazine; but notice of such change with the

the address and calling of the new owner or operator shall be sent to the Minister by the former owner forthwith, and by the new owner within one month after such change, and in default thereof each such owner or operator shall be liable to a penalty not exceeding one hundred dollars for each week during which such default continues, and if the occupier is not himself the owner he shall also be liable to the same penalty.

Notice to Minister.

Penalty.

14. In the case of a factory now in operation or a magazine now in existence, no license shall be required until the first day of January, one thousand nine hundred and sixteen: Provided, however, that if the owner or operator of such factory or magazine desires to make any material alteration in or addition to such factory or magazine, or to rebuild the same or any part thereof, he shall comply with the provisions of section 12 of this Act.

License for factory now in operation.

Proviso.

2. The owner or operator of any such factory or magazine shall, within three months after the passing of this Act, make application to the Minister for a continuing certificate, stating in such application his name and address and the situation of the factory or magazine, and shall supply such particulars and information respecting the same as the Minister may require; and the applicant shall thereupon be granted a continuing certificate in such form as may be prescribed by the Minister, and such factory or magazine shall thereupon be deemed to be duly authorized to manufacture and store explosives.

Application for continuing certificate.

Particulars.

3. Notwithstanding anything in this section, the Minister may require the owner or operator of any factory or magazine to stop using, or to use only under and subject to conditions to be specified by the Minister, any building, structure or premises which, from its situation or from the nature of the processes carried on therein, constitutes, in his opinion, a special danger.

Powers of Minister, in case of special danger.

INSPECTORS.

15. The Governor in Council may appoint a chief inspector of explosives, one or more inspectors of explosives, one or more deputy inspectors of explosives, and one or more chemists of explosives.

Appointment of inspectors.

16. An inspector may, at any time, visit and inspect any factory, magazine and premises where any explosive is being manufactured or stored, or where he has reason to suspect any explosive is being manufactured or stored, and may open and examine any package that he may there find; and the owner and operator of such factory, magazine and

Powers of inspectors.

and premises shall afford such inspector every facility to make such inspection full and complete, and shall supply the inspector with any information that he may require, other than information relating to the cost of manufacturing an explosive.

May require samples.

2. An inspector may require the owner or operator of any factory or magazine, where any explosive is manufactured or stored, or any person employed in any such place, to give him such samples as he may require of any substance therein, whether in the state of raw material, material in course of manufacture, or manufactured material, which the inspector believes to be an explosive, or to be an ingredient from which an explosive may be manufactured.

May open packages.

3. An inspector may, at any time, open or cause to be opened any package or store of material of whatsoever nature, which he believes to contain explosives or ingredients for the manufacture of explosives.

INQUIRIES INTO ACCIDENTS.

Inquiry into accidents.

17. The Minister may direct an inquiry to be made whenever any accidental explosion of any explosive has occurred, or when any accident has been caused by an explosive, and the person authorized by the Minister to conduct such inquiry shall have all the powers and authority of a commissioner appointed under Part I of the *Inquiries Act*.

Exemption where covered by provincial legislation.

2. This section shall not apply, however, where an accident has been caused by an explosion of an explosive occurring in any mine or quarry or metallurgical work in any province in which provision is made by the law of such province for a proper and thorough investigation and inquiry into the cause of such accident.

REGULATIONS.

Regulations.

18. The Governor in Council may make regulations,—

Classify explosives.

(*a*) for classifying explosives, and for prescribing the composition, quality and character of explosives;

Licenses, permits, and certificates.

(*b*) prescribing the form and duration of licenses, permits and certificates issued under this Act, the terms and conditions upon which such licenses, permits and certificates shall be issued, and the fees to be paid therefor;

Importation, packing and transportation.

(*c*) for regulating the importation, packing and handling of explosives, and the transportation of explosives otherwise than by railway;

Inquiries into accidents.

(*d*) for inquiries into the accidental explosion of explosives, and any accident caused by explosives;

(*e*)

Samples Testing.

(*e*) for the taking of samples of explosives required for examination and testing, and for the establishing of testing stations, and of the tests and other examinations to which explosives shall be subjected;

Authorized explosives.

(*f*) prescribing the manner in which an explosive shall be tested and examined before it is declared to be an authorized explosive, and for determining to what examinations and tests authorized explosives shall be subject;

Inspectors and officers.

(*g*) to be observed by inspectors and other officers and employees charged with any duty under this Act, or under any regulations made thereunder;

Factories.

(*h*) relating to the construction, and management and licensing of factories and magazines;

Safety of public and employees.

(*i*) for the safety of the public and of the employees at any factory or magazine, or any person engaged in the handling or packing of explosives, or the transportation of explosives otherwise than by railway;

Location and manufacture.

(*j*) governing the establishment, location and maintenance of factories and magazines, and the manufacture and storage of explosives;

Blending.

(*k*) for blending the inexplosive components of an authorized explosive;

Limiting amounts stored.

(*l*) limiting the amount of authorized explosives that may be kept in places other than licensed factories and magazines, and prescribing the manner in which it shall be handled and stored in such places;

Thawing.

(*m*) regarding the thawing of explosives;

Operation of Act.

(*n*) for the more effective carrying out of this Act.

Publication of regulations.

2. All regulations made under this Act shall be published in *The Canada Gazette*, and upon being so published they shall have the same force as if they formed part of this Act.

OFFENCES AND PENALTIES.

Obstruction of entry and examination by inspector.

19. Every person who fails to permit an inspector to enter upon any property, and to inspect, examine or make inquiries in pursuance of his duties, and every person who fails to comply with any order or direction of such inspector, in pursuance of the requirements of this Act or any regulation made thereunder, or who, in any manner whatsoever, obstructs such inspector in the execution of his duties under this Act, shall be liable to a penalty not exceeding five hundred dollars and costs, or to imprisonment for a term not exceeding six months or to both fine and imprisonment.

Penalty.

Manufacturer's objection to inspector's ruling.

2. Any owner or operator who takes exception to the ruling of an inspector, before such ruling or before the penalty provided for in subsection 1 of this section is enforced as the case may be, may have the facts upon which such ruling is based submitted to the Minister for his consideration and decision.

Reference to Minister.

20.

Trespassing upon premises.

Penalty.

20. Every person who enters without permission or lawful authority or otherwise trespasses upon any factory or magazine shall, for every offence, be liable to a penalty, not exceeding fifty dollars and costs, and may be forthwith removed from such factory or magazine by any constable or by any person employed at such factory or magazine.

Causing explosion or fire.

Penalty.

21. Every person who commits any act which is likely to cause an explosion or fire in or about any factory or magazine, shall be liable to a penalty not exceeding five hundred dollars and costs, or to imprisonment not exceeding six months, or to both such fine and imprisonment.

Possession, sale, manufacture or importation of unauthorized explosive.

Penalty.

22. Every person who, by himself or his agent, has in his possession, sells, offers for sale or manufactures or imports any unauthorized explosive within the meaning of this Act shall, for a first offence, be liable to a penalty not exceeding two hundred dollars and costs, or to imprisonment for a term not exceeding three months, or to both fine and imprisonment, and for each subsequent offence shall be liable to a penalty not exceeding five hundred dollars and costs and not less than fifty dollars and costs, or to imprisonment for a term not exceeding six months, or to both fine and imprisonment.

Contravention of Act.

Penalty.

23. Every person who violates any provision of this Act for which a penalty has not been provided, or any regulation made thereunder, shall, for the first offence, incur a penalty not exceeding two hundred dollars and costs, and for each subsequent offence a penalty not exceeding five hundred dollars and costs.

Disclosing confidential information.

Penalty.

24. Any official employed under this Act who without due authority from the Department discloses any confidential information shall on summary conviction be liable to a penalty not exceeding two hundred and fifty dollars or to imprisonment for a term not exceeding three months and shall not thereafter be eligible for employment in the service of His Majesty.

Recovery of penalties.

25. Every penalty and forfeiture may be recovered in a summary manner under the provisions of Part XV of the *Criminal Code*.

Provincial and municipal laws not affected.

26. Nothing in this Act shall relieve any person of the obligation to comply with the requirements of any license law, or other law or by-law of any province or municipality, lawfully enacted, with regard to the storage, handling, sale or other

other dealing with explosives, nor of any liability or penalty imposed by such law or by-law for any violation thereof.

COMMENCEMENT OF ACT.

27. This Act shall come into force on a day to be fixed by proclamation of the Governor in Council. Commencement of Act.

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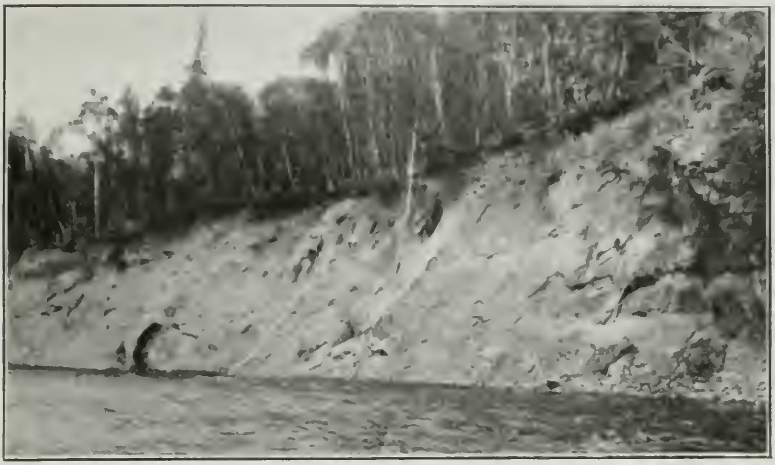
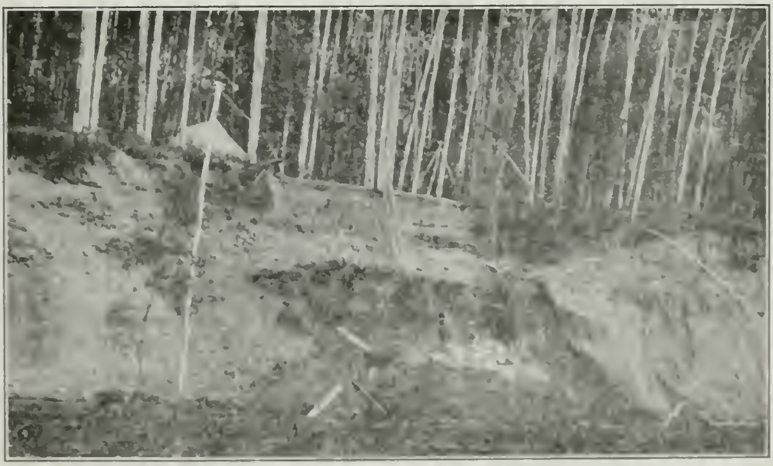
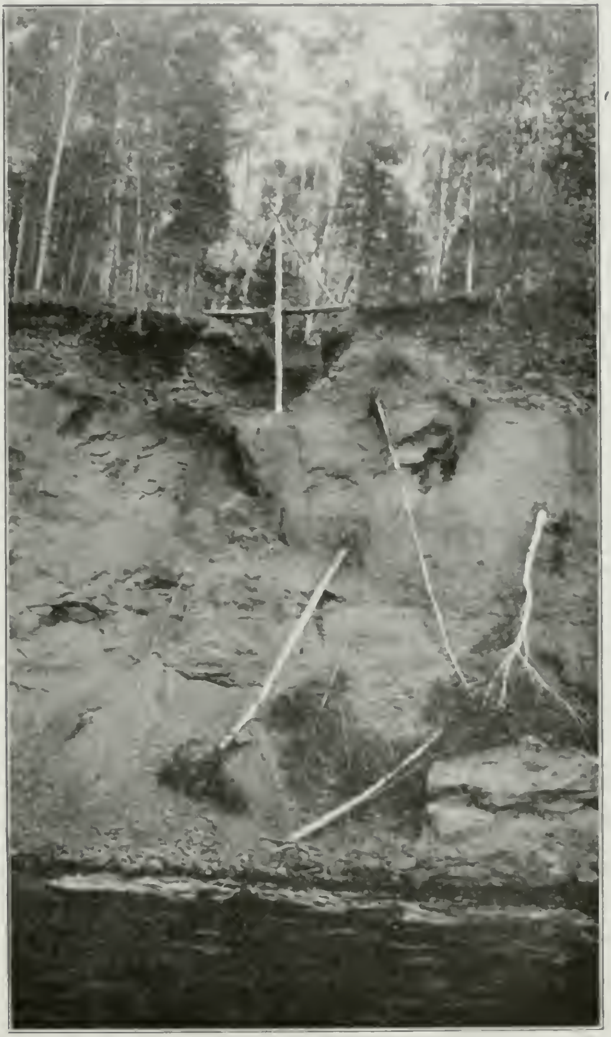


Typical outcrops of bituminous sand on Horse creek.

PLATE II.



Preliminary excavation of outcrop of bituminous sand on Horse creek.



Typical massive structure of bituminous sand on Horse creek.

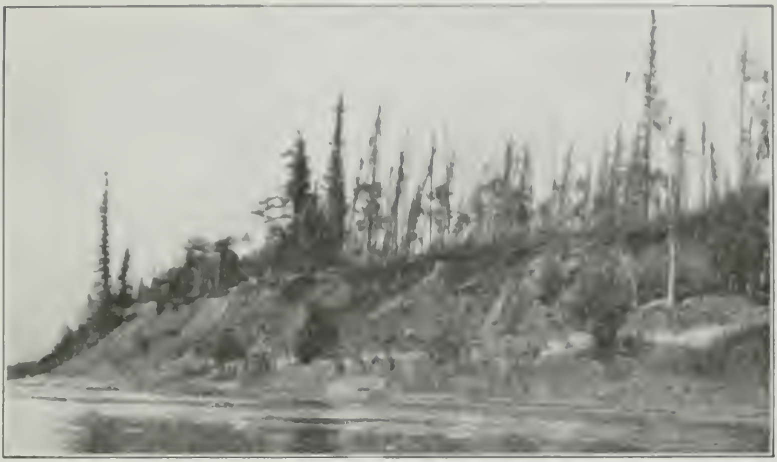
PLATE IV.

Outcrop of bituminous sand on Hangingstone creek, showing light overburden.

PLATE V

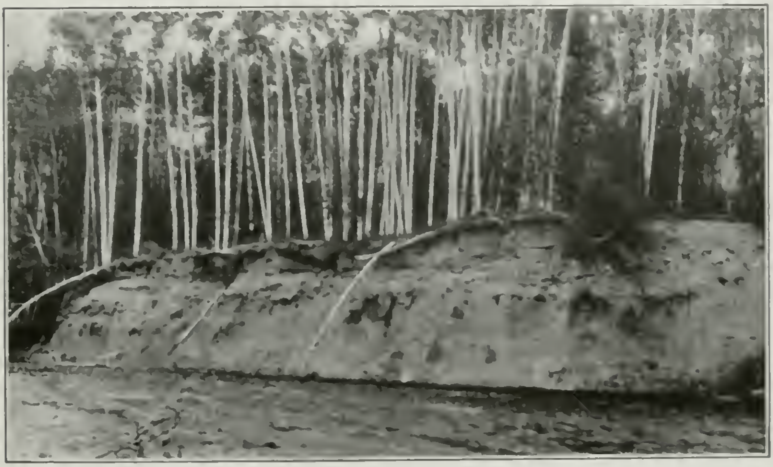
Typical outcrop of bituminous sand on Hangingstone creek, showing heavy overburden.

PLATE VI.



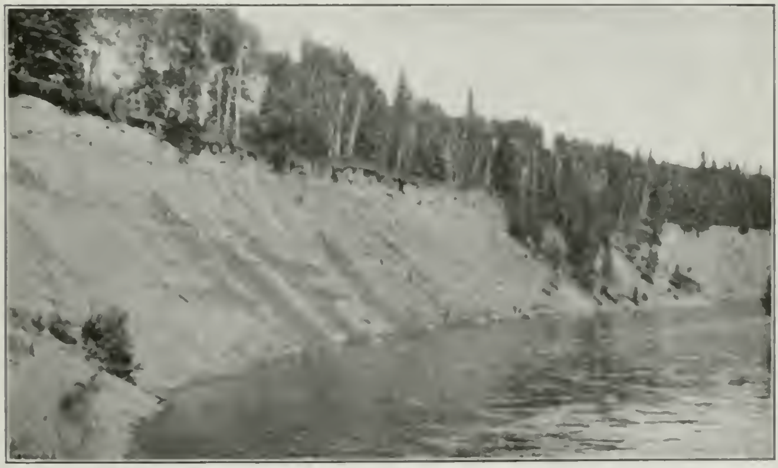
Outcrop on Athabaska river, showing bituminous sand under light overburden.

PLATE VII.

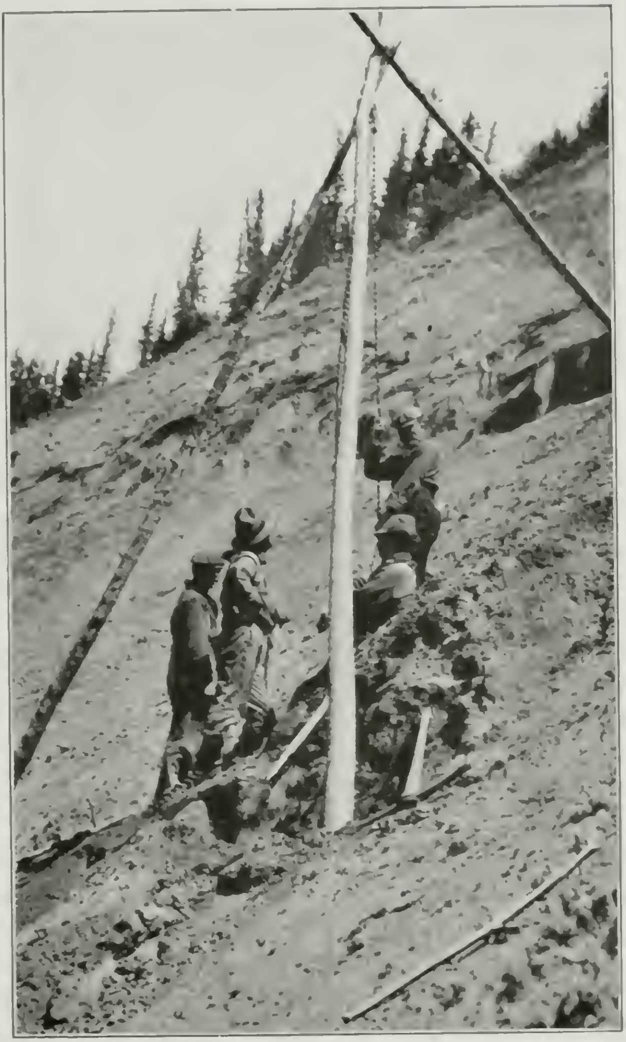


Typical outcrop on Horse creek, showing bituminous sand under light overburden.

Loading trial shipment of bituminous sand from point on east side Athabaska river, 5 miles below McKay.



Outcrop of bituminous sand on east side of McKay river, 12·8 miles from mouth.

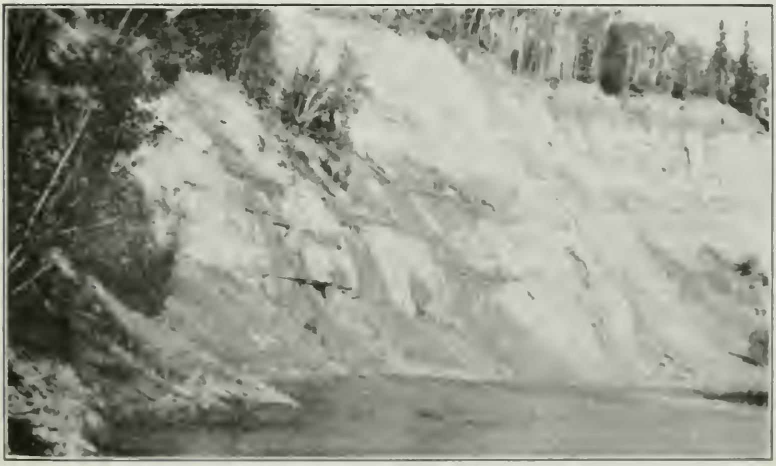


Taking core samples of bituminous sand.

PLATE XI.

West side of Upper Narrows, Buffalo lake, Saskatchewan.

PLATE XII.



Typical outcrop of bituminous sand on west side of Horse creek, 2·3 miles from mouth.

CANADA

DEPARTMENT OF MINES

HON. LOUIS CODERRE, MINISTER; R. G. McCONNELL, DEPUTY MINISTER

MINES BRANCH

EUGENE HAANEL, PH.D., DIRECTOR.

REPORTS AND MAPS

PUBLISHED BY THE

MINES BRANCH

REPORTS.

1. Mining conditions in the Klondike, Yukon. Report on—by Eugene Haanel, Ph.D., 1902.

†2. Great landslide at Frank, Alta. Report on—by R. G. McConnell, B.A., and R. W. Brock, M.A., 1903.

†3. Investigation of the different electro-thermic processes for the smelting of iron ores and the making of steel, in operation in Europe. Report of Special Commission—by Eugene Haanel, Ph.D., 1904.

5. On the location and examination of magnetic ore deposits by magnetometric measurements—by Eugene Haanel, Ph.D., 1904.

†7. Limestones, and the lime industry of Manitoba. Preliminary report on—by J. W. Wells, M.A., 1905.

†8. Clays and shales of Manitoba: their industrial value. Preliminary report on—by J. W. Wells, M.A., 1905.

†9. Hydraulic cements (raw materials) in Manitoba: manufacture and uses of. Preliminary report on—by J. W. Wells, M.A., 1905.

†10. Mica: its occurrence, exploitation, and uses—by Fritz Cirkel, M.E., 1905. (See No. 118.)

†11. Asbestos: its occurrence, exploitation, and uses—by Fritz Cirkel, M.E., 1905. (See No. 69.)

†12. Zinc resources of British Columbia and the conditions affecting their exploitation. Report of the Commission appointed to investigate—by W. R. Ingalls, M.E., 1905.

†16. *Experiments made at Sault Ste. Marie, under Government auspices, in the smelting of Canadian iron ores by the electro-thermic process. Final report on—by Eugene Haanel, Ph.D., 1907.

†17. Mines of the silver-cobalt ores of the Cobalt district: their present and prospective output. Report on—by Eugene Haanel, Ph.D., 1907.

---

* A few copies of the Preliminary Report, 1906, are still available.
† Publications marked thus † are out of print.

†18. Graphite: its properties, occurrence, refining, and uses—by Fritz Cirkel, M.E., 1907.

†19. Peat and lignite: their manufacture and uses in Europe—by Erik Nystrom, M.E., 1908.

†20. Iron ore deposit of Nova Scotia. Report on (Part I)—by J. E. Woodman, D.Sc.

21. Summary report of Mines Branch, 1907–8.

22. Iron ore deposits of Thunder Bay and Rainy River districts. Report on—by F. Hille, M.E.

†23. Iron ore deposits along the Ottawa (Quebec side)and Gatineau rivers. Report on—by Fritz Cirkel, M.E.

24. General report on the mining and metallurgical industries of Canada, 1907–8.

†25. The tungsten ores of Canada. Report on—by T. L. Walker, Ph.D.

26. The mineral production of Canada, 1906. Annual report on—by John McLeish, B.A.

†27. The mineral production of Canada, 1907. Preliminary report on—by John McLeish, B.A.

†27a. The mineral production of Canada, 1908. Preliminary report on—by John McLeish, B.A.

†28. Summary report of Mines Branch, 1908.

29. Chrome iron ore deposits of the Eastern Townships. Monograph on—by Fritz Cirkel. (Supplementary section: Experiments with chromite at McGill University—by J. B. Porter, E.M., D.Sc.)

30. Investigation of the peat bogs and peat fuel industry of Canada, 1908 Bulletin No. 1—by Erik Nystrom, M.E., and A. Anrep, Peat Expert.

32. Investigation of electric shaft furnace, Sweden. Report on—by Eugene Haanel, Ph.D.

47. Iron ore deposits of Vancouver and Texada islands. Report on—by Einar Lindeman, M.E.

†55. The bituminous, or oil-shales of New Brunswick and Nova Scotia; also on the oil-shale industry of Scotland. Report on—by R. W. Ells, LL.D.

58 The mineral production of Canada, 1907 and 1908. Annual report on—by John McLeish, B.A.

† Publications marked thus † are out of print.

NOTE.—*The following parts were separately printed and issued in advance of the Annual Report for 1907-8.*

- †31. Production of cement in Canada, 1908.
- 42. Production of iron and steel in Canada during the calendar years 1907 and 1908.
- 43. Production of chromite in Canada during the calendar years 1907 and 1908.
- 44. Production of asbestos in Canada during the calendar years 1907 and 1908.
- †45. Production of coal, coke, and peat in Canada during the calendar years 1907 and 1908.
- 46. Production of natural gas and petroleum in Canada during the calendar years 1907 and 1908.

59. Chemical analyses of special economic importance made in the laboratories of the Department of Mines, 1906-7-8. Report on—by F. G. Wait, M.A., F.C.S. (With Appendix on the commercial methods and apparatus for the analysis of oil-shales—by H. A. Leverin, Ch. E.)

Schedule of charges for chemical analyses and assays.

†62. Mineral production of Canada, 1909. Preliminary report on—by John McLeish, B.A.

63. Summary report of Mines Branch, 1909.

67. Iron ore deposits of the Bristol mine, Pontiac county, Quebec. Bulletin No. 2—by Einar Lindeman, M.E., and Geo. C. Mackenzie, B.Sc.

†68. Recent advances in the construction of electric furnaces for the production of pig iron, steel, and zinc. Bulletin No. 3—by Eugene Haanel, Ph.D.

69. Chrysotile-asbestos: its occurrence, exploitation, milling, and uses. Report on—by Fritz Cirkel, M.E. (Second edition, enlarged.)

†71. Investigation of the peat bogs, and peat industry of Canada, 1909-10; to which is appended Mr. Alf. Larson's paper on Dr. M. Ekenberg's wet-carbonizing process: from Teknisk Tidskrift, No. 12, December 26, 1908—translation by Mr. A. v. Anrep, Jr.; also a translation of Lieut. Ekelund's pamphlet entitled 'A solution of the peat problem,' 1909, describing the Ekelund process for the manufacture of peat powder, by Harold A. Leverin, Ch.E. Bulletin No. 4—by A. v. Anrep. (Second edition, enlarged.)

82. Magnetic concentration experiments. Bulletin No. 5—by Geo. C Mackenzie, B.Sc.

† Publications marked thus † are out of print.

83. An investigation of the coals of Canada with reference to their economic qualities: as conducted at McGill University under the authority of the Dominion Government. Report on—by J. B. Porter, E.M., D.Sc., R. J. Durley, Ma.E., and others.
    - Vol. I—Coal washing and cooking tests.
    - Vol. II—Boiler and gas producer tests.
    - Vol. III—(Out of print.)
        - Appendix I
            - Coal washing tests and diagrams.
    - Vol. IV—
        - Appendix II
            - Boiler tests and diagrams.
    - Vol. V—(Out of print.)
        - Appendix III
            - Producer tests and diagrams.
    - Vol. VI—
        - Appendix IV
            - Coking tests.
        - Appendix V
            - Chemical tests.

†84. Gypsum deposits of the Maritime provinces of Canada—including the Magalen islands. Report on—by W. F. Jennison, M.E. (See No. 245.)

88. The mineral production of Canada, 1909. Annual report on—by John McLeish, B.A.

    NOTE.—*The following parts were separately printed and issued in advance of the Annual Report for 1909.*

    †79. Production of iron and steel in Canada during the calendar year 1909.
    †80. Production of coal and coke in Canada during the calendar year 1909.
    85. Production of cement, lime, clay products, stone, and other structural materials during the calendar year 1909.

89. Reprint of presidential address delivered before the American Peat Society at Ottawa, July 25, 1910. By Eugene Haanel, Ph.D.

90. Proceedings of conference on explosives.

92. Investigation of the explosives industry in the Dominion of Canada, 1910. Report on—by Capt. Arthur Desborough. (Second edition.)

93. Molybdenum ores of Canada. Report on—by Professor T. L. Walker, Ph.D.

100. The building and ornamental stones of Canada: Building and ornamental stones of Ontario. Report on—by Professor W. A. Parks, Ph.D.

102. Mineral production of Canada, 1910. Preliminary report on—by John McLeish, B.A.

† Publications marked thus † are out of print.

†103. Summary report of Mines Branch, 1910.

104. Catalogue of publications of Mines Branch, from 1902 to 1911; containing tables of contents and lists of maps, etc.

105. Austin Brook iron-bearing district. Report on—by E. Lindeman, M.E.

110. Western portion of Torbrook iron ore deposits, Annapolis county, N.S. Bulletin No. 7—by Howells Fréchette, M.Sc.

111. Diamond drilling at Point Mamainse, Ont. Bulletin No. 6—by A. C. Lane, Ph.D., with introductory by A. W. G. Wilson, Ph.D.

118. Mica: its occurrence, exploitation, and uses. Report on—by Hugh S. de Schmid, M.E.

142. Summary report of Mines Branch, 1911.

143. The mineral production of Canada, 1910. Annual report on—by John McLeish, B.A.

Note. *The following parts were separately printed and issued in advance of the Annual Report for 1910.*

- †114. Production of cement, lime, clay products, stone, and other materials in Canada, 1910.
- †115. Production of iron and steel in Canada during the calendar year 1910.
- †116. Production of coal and coke in Canada during the calendar year 1910.
- †117. General summary of the mineral production of Canada during the calendar year 1910.

145. Magnetic iron sands of Natashkwan, Saguenay county, Que. Report on—by Geo. C. Mackenzie, B.Sc.

†150. The mineral production of Canada, 1911. Preliminary report on—by John McLeish, B.A.

151. Investigation of the peat bogs and peat industry of Canada, 1910-11. Bulletin No. 8—by A. v. Anrep.

154. The utilization of peat fuel for the production of power, being a record of experiments conducted at the Fuel Testing Station, Ottawa 1910-11. Report on—by B. F. Haanel, B.Sc.

167. Pyrites in Canada: its occurrence, exploitation, dressing and uses. Report on—by A. W. G. Wilson, Ph.D.

170. The nickel industry: with special reference to the Sudbury region, Ont. Report on—by Professor A. P. Coleman, Ph.D.

184. Magnetite occurrences along the Central Ontario railway. Report on—by E. Lindeman, M.E.

201. The mineral production of Canada during the calendar year 1911. —Annual report on—by John McLeish, B.A.

† Publications marked thus † are out of print.

NOTE.—*The following parts were separately printed and issued in advance of the Annual Report for 1911.*

181. Production of cement, lime, clay products, stone, and other structural materials in Canada during the calendar year 1911. Bulletin on—by John McLeish, B.A.
†182. Production of iron and steel in Canada during the calendar year 1911. Bulletin on—by John McLeish, B.A.
183. General summary of the mineral production in Canada during the calendar year 1911. Bulletin on—by John McLeish, B.A.
†199. Production of copper, gold, lead, nickel, silver, zinc, and other metals of Canada, during the calendar year 1911. Bulletin on—by C. T. Cartwright, B.Sc.
†200. The production of coal and coke in Canada during the calendar year 1911. Bulletin on—by John McLeish, B.A.

203. Building stones of Canada—Vol. II: Building and ornamental stones of the Maritime Provinces. Report on—by W. A. Parks, Ph.D.

209. The copper smelting industry of Canada. Report on—by A. W. G. Wilson, Ph.D.

216. Mineral production of Canada, 1912. Preliminary report on—by John McLeish, B.A.

222. Lode mining in Yukon: an investigation of the quartz deposits of the Klondike division. Report on—by T. A. MacLean, B.Sc.

224. Summary report of the Mines Branch, 1912.

227. Sections of the Sydney coal fields—by J. G. S. Hudson, M.E.

†229. Summary report of the petroleum and natural gas resources of Canada, 1912—by F. G. Clapp, A.M. (See No. 224.)

230. Ecomomic minerals and mining industries of Canada.

245. Gypsum in Canada: its occurrence, exploitation, and technology. Report on—by L. H. Cole, B.Sc.

254. Calabogie iron-bearing district. Report on—by E. Lindeman, M.E.

259. Preparation of metallic cobalt by reduction of the oxide. Report on—by H. T. Kalmus, B.Sc., Ph.D.

262. The mineral production of Canada during the calendar year 1912. Annual report on—by John McLeish, B.A.

NOTE.—*The following parts were separately printed and issued in advance of the Annual Report for 1912.*

238. General summary of the mineral production of Canada, during the calendar year 1912. Bulletin on—by John McLeish, B.A.

† Publications marked thus † are out of print.

- †247. Production of iron and steel in Canada during the calendar year 1912. Bulletin on—by John McLeish, B.A.
- †256. Production of copper, gold, lead, nickel, silver, zinc, and other metals of Canada, during the calendar year 1912—by C. T. Cartwright, B.Sc.
- 257. Production of cement, lime, clay products, stone, and other structural materials during the calendar year 1912. Report on—by John McLeish, B.A.
- †258. Production of coal and coke in Canada, during the calendar year 1912. Bulletin on—by John McLeish, B.A.

266. Investigation of the peat bogs and peat industry of Canada, 1911 and 1912. Bulletin No. 9—by A. v. Anrep.

279. Building and ornamental stones of Canada—Vol. III: Building and ornamental stones of Quebec. Report on—by W. A. Parks, Ph.D.

281. The bituminous sands of Northern Alberta. Report on—by S. C. Ells, M.E.

283. Mineral production of Canada, 1913. Preliminary report on—by John McLeish, B.A.

285. Summary report of the Mines Branch, 1913.

291. The petroleum and natural gas resources of Canada. Report on—by F. G. Clapp, A.M., and others:—
Vol. I.—Technology and Exploitation.
Vol. II.—Occurrence of petroleum and natural gas in Canada.
Also separates of Vol. II, as follows:—
Part 1, Eastern Canada.
Part 2, Western Canada.

299. Peat, lignite, and coal: their value as fuels for the production of gas and power in the by-product recovery producer. Report on—by B. F. Haanel, B.Sc.

303. Moose Mountain iron-bearing district. Report on—by E. Lindeman, M.E.

305. The non-metallic minerals used in the Canadian manufacturing industries. Report on—by Howells Fréchette, M.Sc.

309. The physical properties of cobalt, Part II. Report on—by H. T. Kalmus, B.Sc., Ph.D.
320. The mineral production of Canada during the calendar year 1913. Annual report on—by John McLeish, B.A.

NOTE.—*The following parts were separately printed and issued in advance of the Annual Report for 1913.*

- 315. The production of iron and steel during the calendar year 1913. Bulletin on—by John McLeish, B.A.

- 316. The production of coal and coke during the calendar year 1913. Bulletin on—by John McLeish, B.A.

† Publications marked thus † are out of print.

317. The production of copper, gold, lead, nickel, silver, zinc, and other metals, during the calendar year 1913. Bulletin on—by C. T. Cartwright, B.Sc.
318. The production of cement, lime, clay products, and other structural materials, during the calendar year 1913. Bulletin on—by John McLeish, B.A.
319. General summary of the mineral production of Canada during the calendar year 1913. Bulletin on—by John McLeish, B.A.

322. Economic minerals and mining industries of Canada. (Panama Edition).

323. The Products and by-products of coal. Report on—by Edgar Stansfield, M.Sc., and F. E. Carter, B.Sc., Dr. Ing.

325. The salt industry of Canada. Report on—by L. H. Cole, B.Sc.

331. The investigation of six samples of Alberta lignites. Report on—by B. F. Haanel, B.Sc., and John Blizard, B.Sc.

333. The mineral production of Canada, 1914. Preliminary report on—by John McLeish, B.A.

334. Electro-plating with cobalt and its alloys. Report on—by H. T. Kalmus, B.Sc., Ph.D.

336. Notes on clay deposits near McMurray, Alberta. Bulletin No. 10—by S. C. Ells, B.A., B.Sc.

344. Electrothermic smelting of iron ores in Sweden. Report on—by Alfred Stansfield, D.Sc., A.R.S.M., F.R.S.C.

346. Summary report of the Mines Branch for 1914.

The Division of Mineral Resources and Statistics has prepared the following lists of mine, smelter, and quarry operators: Metal mines and smelters, Coal mines, Stone quarry operators, Manufacturers of clay products, and Manufacturers of lime; copies of the lists may be obtained on application.

IN THE PRESS.

338. Coals of Canada: Vol. VII. Weathering of coal. Report on—by J. B. Porter, E.M., D.Sc., Ph.D.

348. The production of coal and coke during the calendar year 1914. Bulletin on—by John McLeish, B.A.

349. The production of iron and steel during the calendar year 1914. Bulletin on—by John McLeish, B.A.

350. The production of copper, gold, lead, nickel, silver, zinc, and other metals, during the calendar year 1914. Bulletin on—by John McLeish, B.A.

383. The production of cement, lime, clay products, stone, and other structural materials, during the calendar year 1914. Bulletin on—by John McLeish, B.A.

384. The mineral production of Canada during the calendar year 1914. Annual report on—by John McLeish, B.A.

FRENCH TRANSLATIONS.

†4. Rapport de la Commission nommée pour étudier les divers procédés électro-thermiques pour la réduction des minerais de fer et la fabrication de l'acier employés en Europe—by Eugene Haanel, Ph.D. (French Edition), 1905.

26a. The mineral production of Canada, 1906. Annual report on—by John McLeish, B.A.

†28a. Summary report of Mines Branch, 1908.

56. Bituminous or oil-shales of New Brunswick and Nova Scotia; also on the oil-shale industry of Scotland. Report on—by R. W. Ells, LL.D.

81. Chrysotile-asbestos, its occurrence, exploitation, milling, and uses. Report on—by Fritz Cirkel, M.E.

100a. The building and ornamental stones of Canada: Building and ornamental stones of Ontario. Report on—by W. A. Parks, Ph.D.

149. Magnetic iron sands of Natashkwan, Saguenay county, Que. Report on—by Geo. C. Mackenzie, B.Sc.

155. The utilization of peat fuel for the production of power, being a record of experiments conducted at the Fuel Testing Station, Ottawa, 1910-11. Report on—by B. F. Haanel, B.Sc.

156. The tungsten ores of Canada. Report on—by T. L. Walker, Ph.D.

169. Pyrites in Canada: its occurrence, exploitation, dressing, and uses. Report on—by A. W. C. Wilson, Ph.D.

179. The nickel industry: with special reference to the Sudbury region, Ont. Report on—by Professor A. P. Coleman, Ph.D.

180. Investigation of the peat bogs, and peat industry of Canada, 1910-11. Bulletin No. 8—by A. v. Anrep.

195. Magnetite occurrences along the Central Ontario railway. Report or —by E. Lindeman, M.E.

† Publications marked thus † are out of print.

196. Investigation of the peat bogs and peat industry of Canada, 1909-10; to which is appended Mr. Alf. Larson's paper on Dr. M. Ekenburg's wet-carbonizing process: from Teknisk Tidskrift, No. 12, December 26, 1908—translation by Mr. A. v. Anrep; also a translation of Lieut. Ekelund's pamphlet entitled "A solution of the peat problem," 1909, describing the Ekelund process for the manufacture of peat powder, by Harold A. Leverin, Ch.E. Bulletin No. 4—by A. v. Anrep. (Second Edition, enlarged.)

197. Molybdenum ores of Canada. Report on—by T. L. Walker, Ph.D.

198. Peat and lignite: their manufacture and uses in Europe. Report on—by Erik Nystrom, M.E., 1908.

202. Graphite: its properties, occurrences, refining, and uses. Report on—by Fritz Cirkel, M.E., 1907.

219. Austin Brook iron-bearing district. Report on—by E. Lindeman, M.E.

224a. Mines Branch Summary report for 1912.

226. Chrome iron ore deposits of the Eastern Townships. Monograph on—by Fritz Cirkel, M.E. (Supplementary section: Experiments with chromite at McGill University—by J. B. Porter, E.M., D.Sc.)

231. Ecomomic minerals and mining industries of Canada.

233. Gypsum deposits of the Maritime Provinces of Canada—including the Magdalen islands. Report on—by W. F. Jennison, M.E.

263. Recent advances in the construction of electric furnaces for the production of pig iron, steel, and zinc. Bulletin No. 3—by Eugene Haanel, Ph.D.

264. Mica: its occurrence, exploitation, and uses. Report on—by Hugh S. de Schmid, M.E.

265. Annual mineral production of Canada, 1911. Report on—by John McLeish, B.A.

286. Summary Report of Mines Branch, 1913.

287. Production of iron and steel in Canada during the calendar year 1912. Bulletin on—by John McLeish, B.A.

288. Production of coal and coke in Canada, during the calendar year 1912. Bulletin on—by John McLeish, B.A.

289. Production of cement, lime, clay products, stone, and other structural materials during the calendar year 1912. Bulletin on—by John McLeish, B.A.

290. Production of copper, gold, lead, nickel, silver, zinc, and other metals of Canada during the calendar year 1912. Bulletin on—by C. T. Cartwright, B.Sc.

307. Catalogue of French publications of the Mines Branch and of the Geological Survey, up to July, 1914.

308. An investigation of the coals of Canada with reference to their economic qualities: as conducted at McGill University under the authority of the Dominion Government. Report on—by J. B. Porter, E.M., D.Sc., R. J. Durley, Ma. E., and others—
  Vol. I—Coal washing and coking tests.
  Vol. II—Boiler and gas producer tests.
  Vol. III—
    Appendix I
      Coal washing tests and diagrams.

314. Iron ore deposits, Bristol mine, Pontiac county, Quebec, Report on—by E. Lindeman, M.E.

IN THE PRESS.

204. Building stones of Canada—Vol. II: Building and ornamental stones of the Maritime Provinces. Report on—by W. A. Parks, Ph.D.

223. Lode Mining in the Yukon: an investigation of quartz deposits in the Klondike division. Report on—by T. A. MacLean, B.Sc.

246. Gypsum in Canada: its occurrence, exploitation, and technology. Report on—by L. H. Cole, B.Sc.

260. The preparation of Metallic cobalt by reduction of the oxide. Report on—by H. T. Kalmus, B.Sc., Ph.D.

280. The building and ornamental stones of Canada, Vol. III; Province of Quebec. Report on—by Professor W. A. Parks, Ph.D.

306. The non-metallic minerals used in the Canadian manufacturing industries. Report on—by Howells Fréchette, M.Sc.

308. An investigation of the coals of Canada with reference to their economic qualities: as conducted at McGill University under the authority of the Dominion Government. Report on—by J. B. Porter, E.M., D.Sc., R. J. Durley, Ma.E., and others—
  Vol. IV—
    Appendix II
      Boiler tests and diagrams.

321. Annual mineral production of Canada, during the calendar year 1913. Report on—by J. McLeish, B.A.

MAPS.

†6. Magnetometric survey, vertical intensity: Calabogie mine, Bagot township, Renfrew county, Ontario—by E. Nystrom, 1904. Scale 60 feet to 1 inch. Summary report 1905. (See Map No. 249.)

†13. Magnetometric survey of the Belmont iron mines, Belmont township, Peterborough county, Ontario—by B. F. Haanel, 1905. Scale 60 feet to 1 inch. Summary report, 1906. (See Map No. 186.)

†14. Magnetometric survey of the Wilbur mine, Lavant township, Lanark county, Ontario—by B. F. Haanel, 1906. Scale 60 feet to 1 inch. Summary report, 1906.

†33. Magnetometric survey, vertical intensity: lot 1, concession VI, Mayo township, Hastings county, Ontario—by Howells Fréchette, 1909. Scale 60 feet to 1 inch. (See Maps Nos. 191 and 191A.)

†34. Magnetometric survey, vertical intensity: lots 2 and 3, concession VI, Mayo township, Hastings county, Ontario—by Howells Fréchette, 1909. Scale 60 feet to 1 inch. (See Maps Nos. 191 and 191A.)

†35. Magnetometric survey, vertical intensity: lots 10, 11, and 12, concession IX, and lots 11 and 12, concession VIII, Mayo township, Hastings county, Ontario—by Howells Fréchette, 1909. Scale 60 feet to 1 inch. (See Maps Nos. 191 and 191A.)

*36. Survey of Mer Bleue peat bog, Gloucester township, Carleton county, and Cumberland township, Russell county, Ontario—by Erik Nystrom, and A. v. Anrep. (Accompanying report No. 30.)

*37. Survey of Alfred peat bog, Alfred and Caledonia townships, Prescott county, Ontario—by Erik Nystrom and A. v. Anrep. (Accompanying report No. 30.)

*38. Survey of Welland peat bog, Wainfleet and Humberstone townships, Welland county, Ontario—by Erik Nystrom and A. v. Anrep. (Accompanying report No. 30.)

*39. Survey of Newington peat bog, Osnabruck, Roxborough, and Cornwall townships, Stormont county, Ontario—by Erik Nystrom and A. v. Anrep. (Accompanying report No. 30.)

*40. Survey of Perth peat bog, Drummond township, Lanark county, Ontario—by Erik Nystrom and A. v. Anrep. (Accompanying report No. 30.)

†41. Survey of Victoria Road peat bog, Bexley and Carden townships, Victoria county, Ontario—by Erik Nystrom and A. v. Anrep. (Accompanying report No. 30.)

*48. Magnetometric survey of Iron Crown claim at Nimpkish (Klaanch) river, Vancouver island, B.C.—by E. Lindeman. Scale 60 feet to 1 inch. (Accompanying report No. 47.)

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*49. Magnetometric survey of Western Steel Iron claim, at Sechart, Vancouver island, B.C.—By E. Lindeman. Scale 60 feet to 1 inch. (Accompanying report No. 47).

*53. Iron ore occurrences, Ottawa and Pontiac counties, Quebec, 1908—by J. White and Fritz Cirkel. (Accompanying report No. 23.)

*54. Iron ore occrurences, Argenteuil county, Quebec, 1908—by Fritz Cirkel. (Accompanying report No. 23.) (Out of print.)

*57. The productive chrome iron ore district of Quebec—by Fritz Cirkel. (Accompanying report No. 29.)

†60. Magnetometric survey of the Bristol mine, Pontiac county, Quebec—by E. Lindeman. Scale 200 feet to 1 inch. (Accompanying report No. 67.)

†61. Topographical map of Bristal mine, Pontiac county, Quebec—by E. Lindeman. Scale 200 feet to 1 inch. (Accompanying report No. 67.)

†64. Index map of Nova Scotia: Gypsum—by W. F. Jennison.
†65. Index map of New Brunswick: Gypsum—by W. F. Jennison.
†66. Map of Magdalen islands: Gypsum—by W. F. Jennison.
(Accompanying report No. 84.)

†70. Magnetometric survey of Northeast Arm iron range, Lake Timagami, Nipissing district, Ontario—by E. Lindeman. Scale 200 feet to 1 inch. (Accompanying report No. 63.)

†72. Brunner peat bog, Ontario—by A. v. Anrep.
†73. Komoko peat bog, Ontario—by A. v. Anrep.
†74. Brockville peat bog, Ontario—by A. v. Anrep
†75. Rondeau peat bog, Ontario—by A. v. Anrep.
†76. Alfred peat bog, Ontario—by A. v. Anrep.
†77. Alfred peat bog, Ontario: main ditch profile—by A. v. Anrep.
(Accompanying report No. 71.)
(Out of print.)

†78. Map of asbestos region, Province of Quebec, 1910—by Fritz Cirkel. Scale 1 mile to 1 inch. (Accompanying report No. 69.)

†94. Map showing Cobalt, Gowganda, Shiningtree, and Porcupine districts—by L. H. Cole. (Accompanying Summary report, 1910.)

†95. General map of Canada, showing coal fields. (Accompanying report No. 83—by Dr. J. B. Porter.)

†96. General map of coal fields of Nova Scotia and New Brunswick. (Accompanying report No. 83—By Dr. J. B. Porter.)

†97. General map showing coal fields in Alberta, Saskatchewan, and Manitoba. (Accompanying report No. 83—by Dr. J. B. Porter).

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†98. General map of coal fields in British Columbia. (Accompanying report No. 83—by Dr. J. B. Porter.)

†99. General map of coal field in Yukon Territory. (Accompanying report No. 83—by Dr. J. B. Porter.)

†106. Geological map of Austin Brook iron-bearing district, Bathurst township, Gloucester county, N.B.—by E. Lindeman. Scale 400 feet to 1 inch. (Accompanying report No. 105.)

†107. Magnetometric survey, vertical intensity: Austin Brook iron-bearing district—by E. Lindeman. Scale 400 feet to 1 inch. (Accompanying report No. 105.)

†108. Index map showing iron-bearing area at Austin Brook—by E. Lindeman. (Accompanying report No. 105.)

*112. Sketch plan showing geology of Point Mamainse, Ont.—by Professor A. C. Lane. Scale 4,000 feet to 1 inch. (Accompanying report No. 111.)

†113. Holland peat bog Ontario—by A. v. Anrep. (Accompanying report No. 151.)

*119–137. Mica: township maps, Ontario and Quebec—by Hugh S. de Schmid. (Accompanying report No. 118.)

†138. Mica: showing location of principal mines and occurrences in the Quebec mica area—by Hugh S. de Schmid. Scale 3·95 miles to 1 inch. (Accompanying report No. 118.)

†139. Mica: showing location of principal mines and occurrences in the Ontario mica area—by Hugh S. de Schmid. Scale 3·95 miles to 1 inch. (Accompanying report No. 118.)

†140. Mica: showing distribution of the principal mica occurrences in the Dominion of Canada—by Hugh S. de Schmid. Scale 3·95 miles to 1 inch. (Accompanying report No. 118.)

†141. Torbrook iron bearing district, Annapolis county, N.S.—by Howells Fréchette. Scale 400 feet to 1 inch. (Accompanying report No. 110).

†146. Distribution of iron ore sands of the iron ore deposits on the north shore of the River and Gulf of St. Lawrence, Canada—by Geo. C. Mackenzie. Scale 100 miles to 1 inch. (Accompanying report No. 145.)

†147. Magnetic iron sand deposits in relation to Natashkwan harbour and Great Natashkwan river, Que. (Index Map)—by Geo. C. Mackenzie. Scale 40 chains to 1 inch. (Accompanying report No. 145.)

†148. Natashkwan magnetic iron sand deposits, Saguenay county, Que.—by Geo. C. Mackenzie. Scale 1,000 feet to 1 inch. (Accompanying report No. 145.)

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†152. Map showing the location of peat bogs investigated in Ontario—by A. v. Anrep.

†153. Map showing the location of peat bog as investigated in Manitoba—by A. v. Anrep.

†157. Lac du Bonnet peat bog, Manitoba—by A. v. Anrep.

†158. Transmission peat bog, Manitoba—by A. v. Anrep.

†159. Corduroy peat bog, Manitoba—by A. v. Anrep.

†160. Boggy Creek peat bog, Manitoba—by A. v. Anrep.

†161. Rice Lake peat bog, Manitoba—by A. v. Anrep.

†162. Mud Lake peat bog, Manitoba—by A. v. Anrep.

†163. Litter peat bog, Manitoba—by A. v. Anrep.

†164. Julius peat litter bog, Manitoba—by A. v. Anrep.

†165. Fort Francis peat bog, Ontario—by A. v. Anrep.

(Accompanying report No. 151.)

†166. Magnetometric map of No. 3 mine, lot 7, concessions V and VI, McKim township, Sudbury district, Ont.—by E. Lindeman. (Accompanying Summary report, 1911.)

†168. Map showing pyrites mines and prospects in Eastern Canada, and their relation to the United States market—by A. W. G. Wilson. Scale 125 miles to 1 inch. (Accompanying report No. 167.)

†171. Geological map of Sudbury nickel region, Ont.—by Prof. A. P. Coleman. Scale 1 mile to 1 inch. (Accompanying report No. 170.)

†172. Geological map of Victoria mine—by Prof. A. P. Coleman.

†173. " Crean Hill mine—by Prof. A. P. Coleman

†174. " Creighton mine—by Prof. A. P. Coleman.

(Accompanying report No. 170.)

†175. " showing contact of norite and Laurentian in vicinity of Creighton mine—by Prof. A. P. Coleman. (Accompanying report No. 170.)

†176. " Copper Cliff offset—by Prof. A. P. Coleman. (Accompanying report No. 170.)

†177. " No. 3 mine—by Prof. A. P. Coleman. (Accompanying report No. 170.)

†178. " showing vicinity of Stobie and No. 3 mines—by Prof. A. P. Coleman. (Accompanying report No. 170.)

Note.—1. Maps marked thus * are to be found only in reports.
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†185. Magnetometric survey, vertical intensity: Blairton iron mine, Belmont township, Peterborough county, Ontario—by E. Lindeman, 1911. Scale 200 feet to 1 inch. (Accompanying report No. 184.)

†185a. Geological map, Blairton iron mine, Belmont township, Peterborough county, Ontario—by E. Lindeman, 1911. Scale 200 feet to 1 inch. (Accompanying report No. 184.)

†186. Magnetometric survey, Belmont iron mine, Belmont township, Peterborough county, Ontario—by E. Lindeman, 1911. Scale 200 feet to 1 inch. (Accompanying report No. 184.)

†186a. Geological map, Belmont iron mine, Belmont township, Peterborough county, Ontario—by E. Lindeman, 1911. Scale 200 feet to 1 inch. (Accompanying report No. 184.)

†187. Magnetometric survey, vertical intensity: St. Charles mine, Tudor township, Hastings county, Ontario—by E. Lindeman, 1911. Scale 200 feet to 1 inch. (Accompanying report No. 184.)

†187a. Geological map, St. Charles mine, Tudor township, Hastings county, Ontario—by E. Lindeman, 1911. Scale 200 feet to 1 inch. (Accompanying report No. 184.)

†188. Magnetometric survey, vertical intensity: Baker mine, Tudor township, Hastings county, Ontario—by E. Lindeman, 1911. Scale 200 feet to 1 inch. (Accompanying report No. 184.)

†188a. Geological map, Baker mine, Tudor township, Hastings county, Ontario—by E. Lindeman, 1911. Scale 200 feet to 1 inch. (Accompanying report No. 184.)

†189. Magnetometric survey, vertical intensity: Ridge iron ore deposits, Wollaston township, Hastings county, Ontario—by E. Lindeman, 1911. Scale 200 feet to 1 inch. (Accompanying report No. 184.)

†190. Magnetometric survey, vertical intensity: Coehill and Jenkins mines, Wollaston township, Hastings county, Ontario—by E. Lindeman, 1911. Scale 200 feet to 1 inch. (Accompanying report No. 184.)

†190a. Geological map, Coehill and Jenkins mines, Wollaston township, Hastings county, Ontario—by E. Lindeman, 1911. Scale 200 feet to 1 inch. (Accompanying report No. 184.)

†191. Magnetometric survey, vertical intensity: Bessemer iron ore deposits, Mayo township, Hastings county, Ontario—by E. Lindeman, 1911. Scale 200 feet to 1 inch. (Accompanying report No. 184.)

†191a. Geological map, Bessemer iron ore deposits, Mayo township, Hastings county, Ontario—by E. Lindeman, 1911. Scale 200 feet to 1 inch. (Accompanying report No. 184.)

†192. Magnetometric survey, vertical intensity: Rankin, Childs, and Stevens mines, Mayo township, Hastings county, Ontario—by E. Lindeman, 1911. Scale 200 feet to 1 inch. (Accompanying report No. 194.)

Note.—1. Maps marked thus * are to be found only in reports.
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†192a. Geological map, Rankin, Childs, and Stevens mines, Mayo township, Hastings county, Ontario—by E. Lindeman, 1911. Scale 200 feet to 1 inch. (Accompanying report No. 184.)

†193. Magnetometric survey, vertical intensity: Kennedy property, Carlow township, Hastings county, Ontario—by E. Lindeman, 1911. Scale 200 feet to 1 inch. (Accompanying report No. 184.)

†193a. Geological map, Kennedy property, Carlow township, Hastings county, Ontario—by E. Lindeman, 1911. Scale 200 feet to 1 inch. (Accompanying report No. 184.)

†194. Magnetometric survey, vertical intensity: Bow Lake iron ore occurrences, Faraday township, Hastings county, Ontario—by E. Lindeman, 1911. Scale 200 feet to 1 inch. (Accompanying report No. 184.)

†204. Index map, magnetite occurrences along the Central Ontario railway—by E. Lindeman, 1911. (Accompanying report No. 184.)

†205. Magnetometric map, Moose Mountain iron-bearing district, Sudbury district, Ontario: Deposits Nos. 1, 2, 3, 4, 5, 6, and 7—by E. Lindeman, 1911. (Accompanying report No. 303.)

†205a. Geological map, Moose Mountain iron-bearing district, Sudbury district, Ontario, Deposits Nos. 1, 2, 3, 4, 5, 6, and 7—by E. Lindeman. (Accompanying report No. 303.)

†206. Magnetometric survey of Moose Mountain iron-bearing district, Sudbury district, Ontario: northern part of deposit No. 2—by E. Lindeman, 1912. Scale 200 feet to 1 inch. (Accompanying report No. 303.)

†207. Magnetometric survey of Moose Mountain iron-bearing district, Sudbury district, Ontario: Deposits Nos. 8, 9, and 9A—by E. Lindeman, 1912. Scale 200 feet to 1 inch. (Accompanying report No. 303.)

†208. Magnetometric survey of Moose Mountain iron-bearing district, Sudbury district, Ontario: Deposit No. 10—by E. Lindeman, 1912. Scale 200 feet to 1 inch. (Accompanying report No. 303.)

†208a. Magnetometric survey, Moose Mountain iron-bearing district, Sudbury district, Ontario: eastern portion of Deposit No. 11—by E. Lindeman, 1912. Scale 200 feet to 1 inch. (Accompanying report No. 303.)

†208b. Magnetometric survey, Moose Mountain iron-bearing district, Sudbury district, Ontario: western portion of deposit No. 11—by E. Lindeman, 1912. Scale 200 feet to 1 inch. (Accompanying report No. 303.)

†208c. General geological map, Moose Mountain iron-bearing district, Sudbury district, Ontario—by E. Lindeman, 1912. Scale 800 feet to 1 inch. (Accompanying report No. 303.)

Note.—1. Maps marked thus * are to be found only in reports.
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†210. Location of copper smelters in Canada—by A. W. G. Wilson. Scale 197·3 miles to 1 inch. (Accompanying report No. 209.)

†215. Province of Alberta: showing properties from which samples of coal were taken for gas producer tests, Fuel Testing Division, Ottawa. (Accompanying Summary report, 1912.)

†220. Mining districts, Yukon. Scale 35 miles to 1 inch—by T. A. MacLean (Accompanying report No. 222.)

†221. Dawson mining district, Yukon, Scale 2 miles to 1 inch—by T. A. MacLean. (Accompanying report No. 222.)

*228. Index map of the Sydney coal fields, Cape Breton, N.S. (Accompanying report No. 227.)

†232. Mineral map of Canada. Scale 100 miles to 1 inch. (Accompanying report No. 230.)

†239. Index map of Canada showing gypsum occurrences. (Accompanying report No. 245.)

†240. Map showing Lower Carboniferous formation in which gypsum occurs in the Maritime provinces. Scale 100 miles to 1 inch. (Accompanying report No. 245.)

†241. Map showing relation of gypsum deposits in Northern Ontario to railway lines. Scale 100 miles to 1 inch. (Accompanying report No. 245.)

†242. Map, Grand River gypsum deposits, Ontario. Scale 4 miles to 1 inch. (Accompanying report No. 245.)

†243. Plan of Manitoba Gypsum Co.'s properties. (Accompanying report No. 245.)

†244. Map showing relation of gypsum deposits in British Columbia to railway lines and market. Scale 35 miles to 1 inch. (Accompanying report No. 245.)

†249. Magnetometric survey, Caldwell and Campbell mines, Calabogie district, Renfrew county, Ontario—by E. Lindeman, 1911. Scale 200 feet to 1 inch. (Accompanying report No. 254.)

†250. Magnetometric survey, Black Bay or Williams mine, Calabogie district, Renfrew county, Ontario—by E. Lindeman, 1911. Scale 200 feet to 1 inch. (Accompanying report No. 254.)

†251. Magnetometric survey, Bluff Point iron mine, Calabogie district, Renfrew county, Ontario—by E. Lindeman, 1911. Scale 200 feet to 1 inch. (Accompanying report No. 254.)

†252. Magnetometric survey, Culhane mine, Calabogie district, Renfrew county, Ontario—by E. Lindeman, 1911. Scale 200 feet to 1 inch. (Accompanying report No. 254.)

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†253. Magnetometric survey, Martel or Wilson iron mine, Calabogie district, Renfrew county, Ontario—by E. Lindeman, 1911. Scale 200 feet to 1 inch. (Accompanying report No. 254.)

†261. Magnetometric survey, Northeast Arm iron range, lot 339 E.T.W. Lake Timagami, Nipissing district, Ontario—by E. Nystrom. 1903. Scale 200 feet to 1 inch.

†268. Map of peat bogs investigated in Quebec—by A.v. Anrep, 1912.

†269. Large Tea Field peat bog, Quebec " "

†270. Small Tea Field peat bog, Quebec " "

†271. Lanoraie peat bog, Quebec " "

†272. St. Hyacinthe peat bog, Quebec " "

†273. Rivière du Loup peat bog " "

†274. Cacouna peat bog " "

†275. Le Parc peat bog, Quebec " "

†276. St. Denis peat bog, Quebec " "

†277. Rivière Ouelle peat bog, Quebec " "

†278. Moose Mountain peat bog, Quebec " "

†284. Map of northern portion of Alberta, showing position of outcrops of bituminous sand. Scale 12½ miles to 1 inch. (Accompanying report No. 281.)

†293. Map of Dominion of Canada, showing the occurrences of oil, gas, and tar sands. Scale 197 miles to 1 inch. (Accompanying report No. 291.)

†294. Reconnaissance map of part of Albert and Westmorland counties, New Brunswick. Scale 1 mile to 1 inch. (Accompanying report No. 291.)

*295. Sketch plan of Gaspé oil fields, Quebec, showing location of wells. Scale 2 miles to 1 inch. (Accompanying report No. 291.)

†296. Map showing gas and oil fields and pipe-lines in southwestern Ontario. Scale 4 miles to 1 inch. (Accompanying report No. 291.)

†297. Geological map of Alberta, Saskatchewan, and Manitoba. Scale 35 miles to 1 inch. (Accompanying report No. 291.)

†298. Map, geology of the forty-ninth parallel, 0·9864 miles to 1 inch. (Accompanying report No. 291.)

†302. Map showing location of main gas line, Bow Island, Calgary. Scale 12½ miles to 1 inch. (Accompanying report No. 291.)

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†311. Magnetometric map, McPherson mine, Barachois, Cape Breton county, Nova Scotia—by A. H. A. Robinson, 1913. Scale 200 feet to 1 inch.

†312. Magnetometric map, iron ore deposits at Upper Glencoe, Inverness county, Nova Scotia—by E. Lindeman, 1913. Scale 200 feet to 1 inch.

†313. Magnetometric map, iron ore deposits at Grand Mira, Cape Breton county, Nova Scotia—by A. H. A. Robinson, 1913. Scale 200 feet to 1 inch.

Address all communications to—

DIRECTOR MINES BRANCH,
DEPARTMENT OF MINES,
SUSSEX STREET, OTTAWA.

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